US006003280A

United States Patent [19]

Wells

[11] **Patent Number: 6,003,280**

[45] **Date of Patent: Dec. 21, 1999**

[54] **MODULAR FRAME BUILDING**

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[73] Assignee: **Inter-Steel Structures, Inc.**, Bellevue, Wash.

[21] Appl. No.: **08/952,589**

[22] PCT Filed: **Aug. 2, 1996**

[86] PCT No.: **PCT/US96/12659**

§ 371 Date: **Nov. 19, 1997**

§ 102(e) Date: **Nov. 19, 1997**

[87] PCT Pub. No.: **WO97/05340**

PCT Pub. Date: **Feb. 13, 1997**

[51] **Int. Cl.**^{6} **E04H 12/00**

[52] **U.S. Cl.** **52/653.1**; 52/653.2; 52/690

[58] **Field of Search** 52/648.1, 653.1, 52/653.2, 656.2, 690, 693, 694, 292, 293.3, 295, 296, 297

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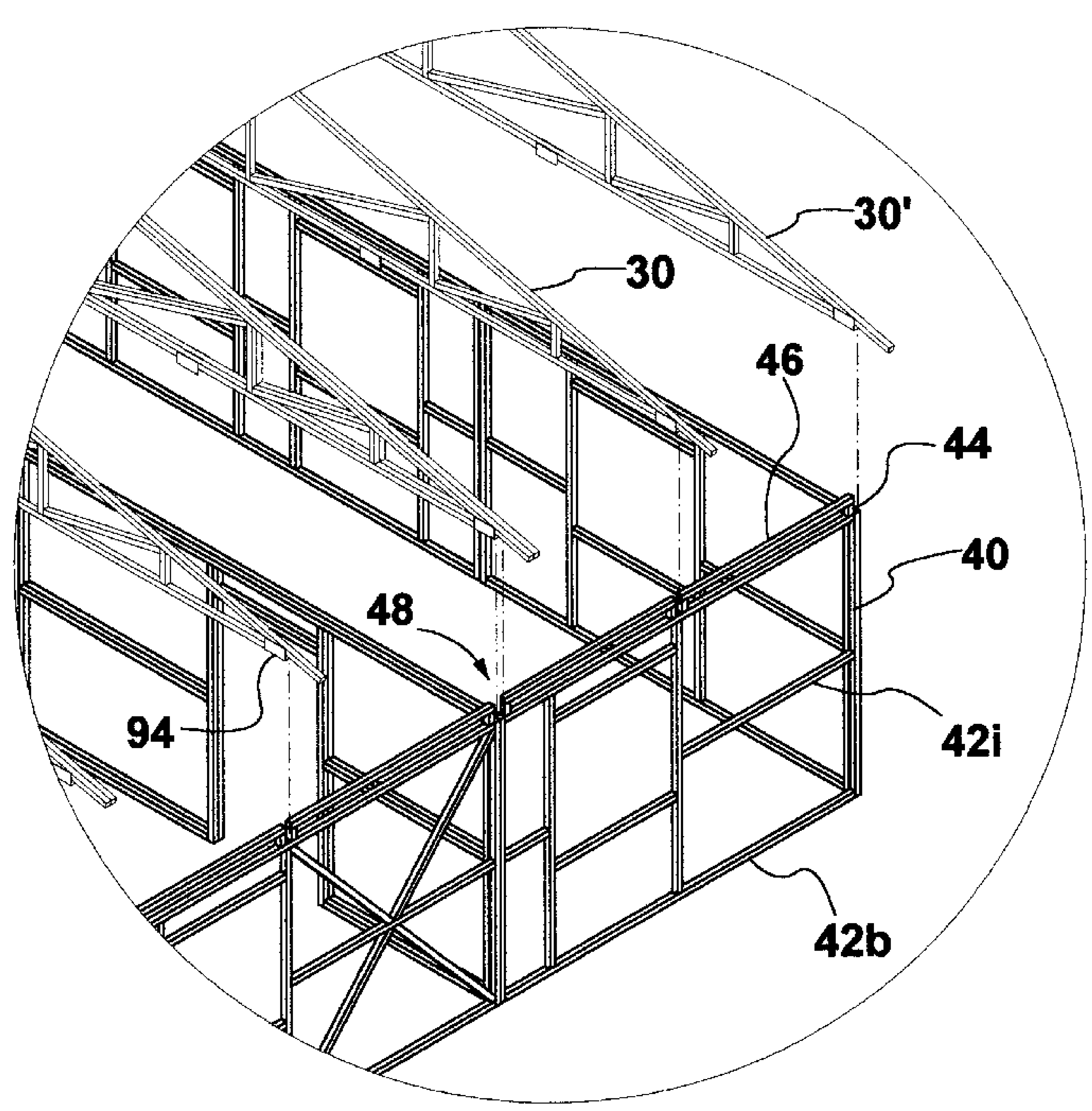
Primary Examiner—Creighton Smith
Attorney, Agent, or Firm—J. Michael Neary

[57] **ABSTRACT**

A building frame resistant to earthquakes, wind loads, fire, insects and rot includes a peripheral frame wall made of side wall frame modules bolted together along adjacent edges, and end wall modules bolted together along adjacent edges and to the ends of the connected side wall modules. The side wall frame modules are constructed of rectangular steel tubing jig welded together off site at precisely 90° angles so that the assembled building frame is square and true. Diagonal bracing is built into selected side and end wall modules as required for the desired degree of wind resistance. Trusses for supporting a roof on the peripheral wall, also made of rectangular steel tubing, are assembled and welded, and the trusses and wall modules are trucked to the building site. The trusses are fitted at their ends into pockets on top of the side walls at the junctions between adjacent side wall modules and bolted in place where they are vertically supported on the adjoining end members of adjacent side wall modules to secure the roof of the building on the peripheral wall. Anchors set in a foundation are positioned at intersections of the frame modules to complete a vertical tensile load path from the roof to the foundation for holding the roof down in high winds, and to secure the building frame to the foundation against lateral forces exerted by wind loads or earthquakes.

21 Claims, 26 Drawing Sheets



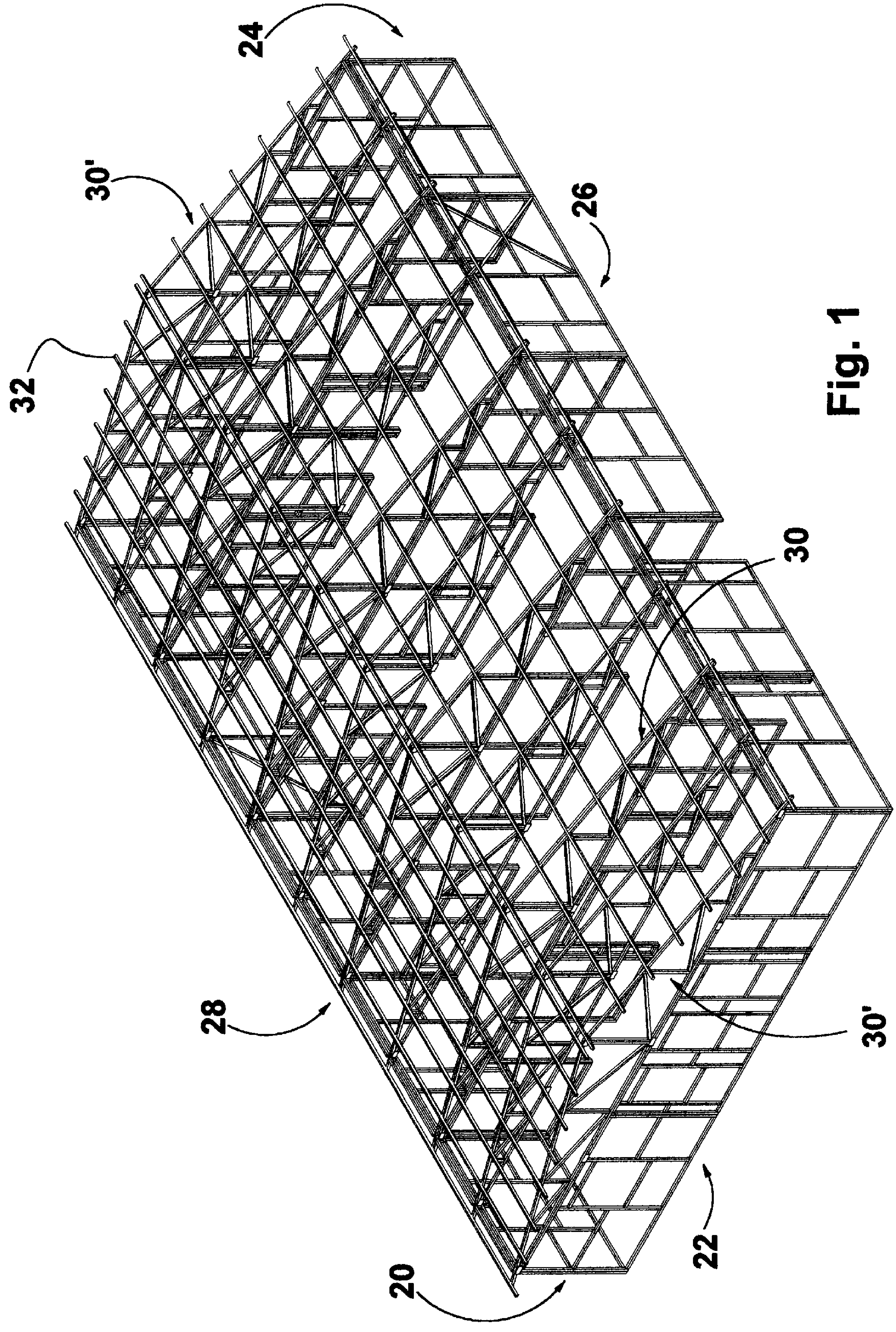


Fig. 1

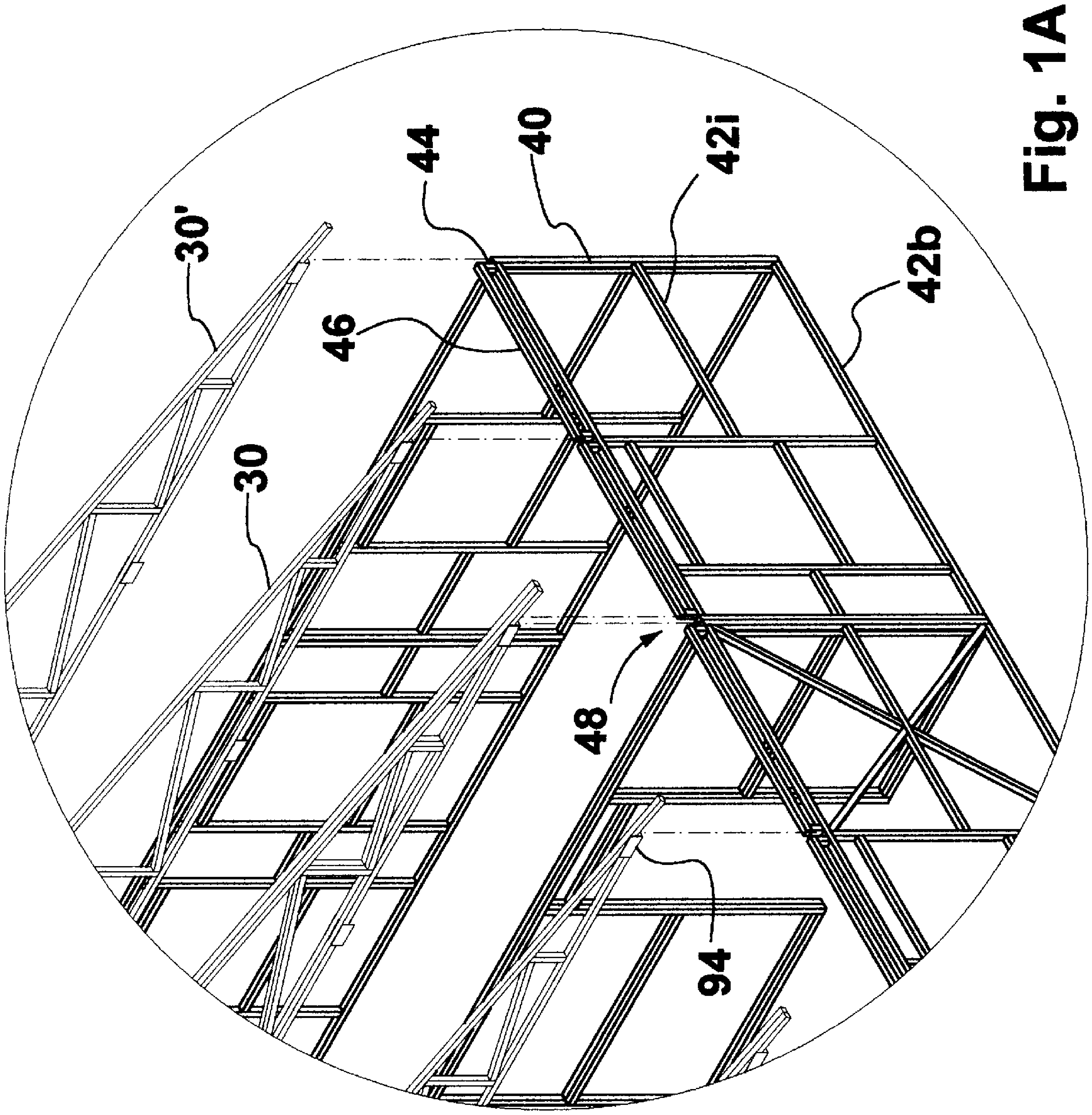


Fig. 1A

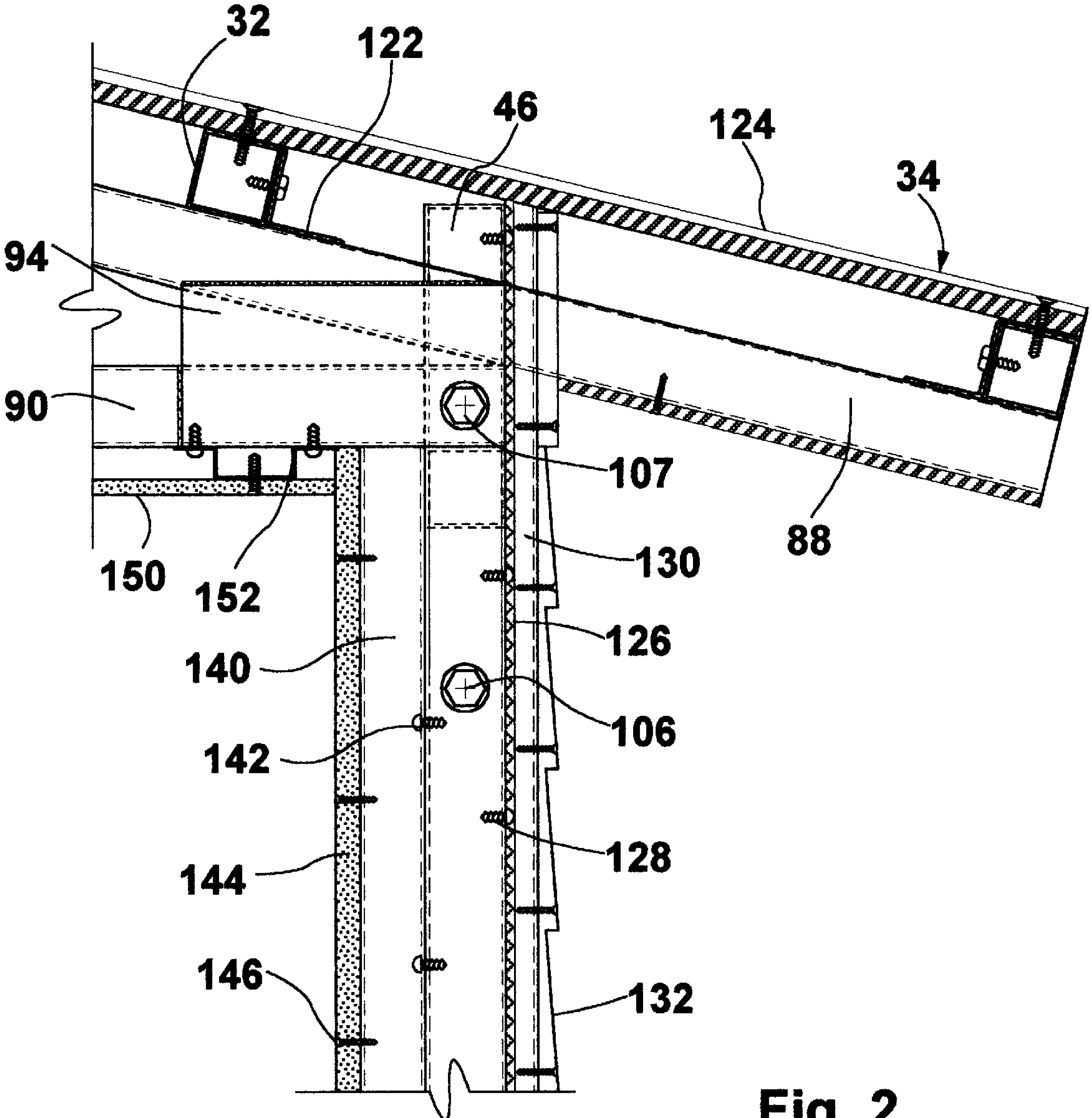

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Fig. 2

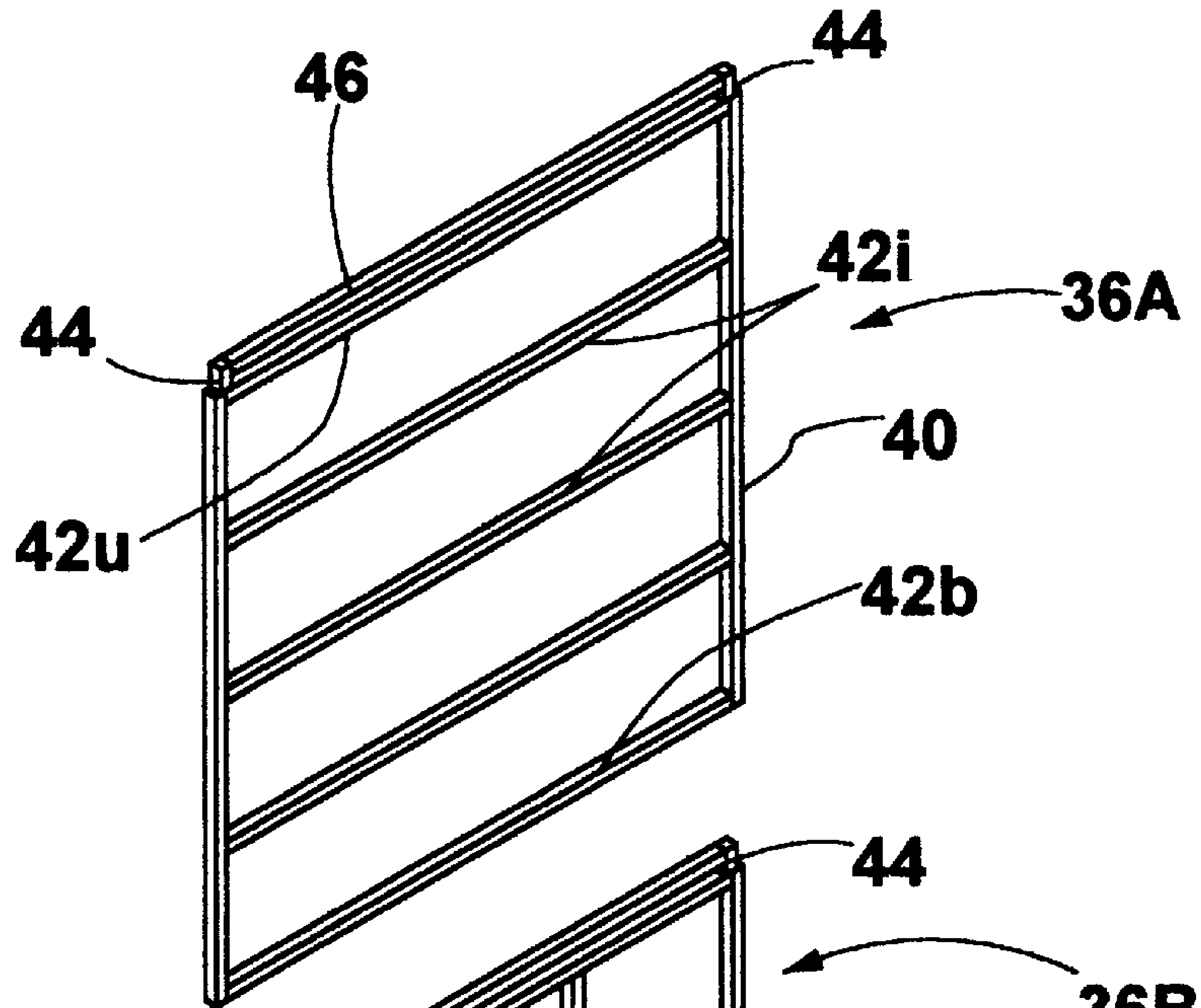


Fig. 3A

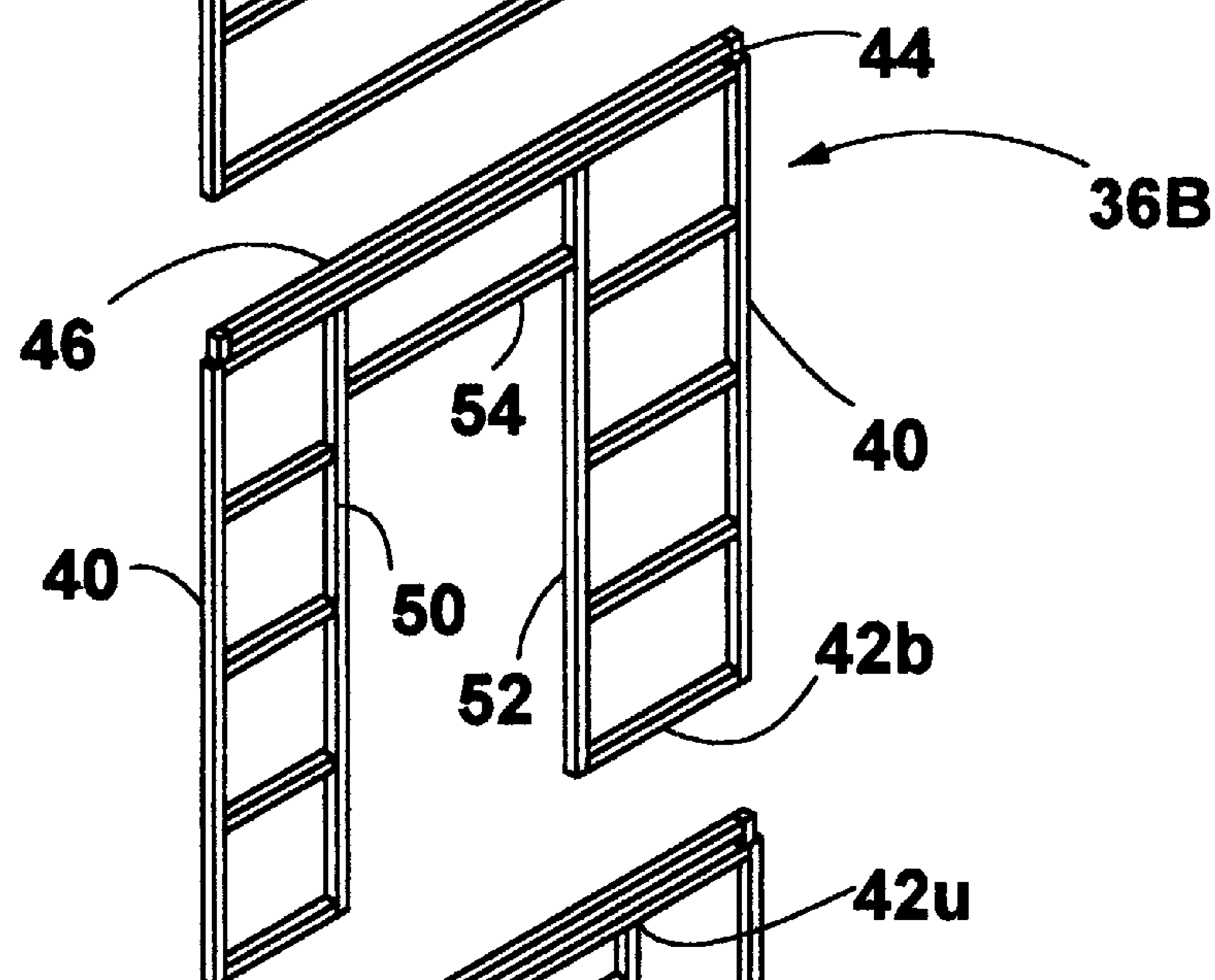


Fig. 3B

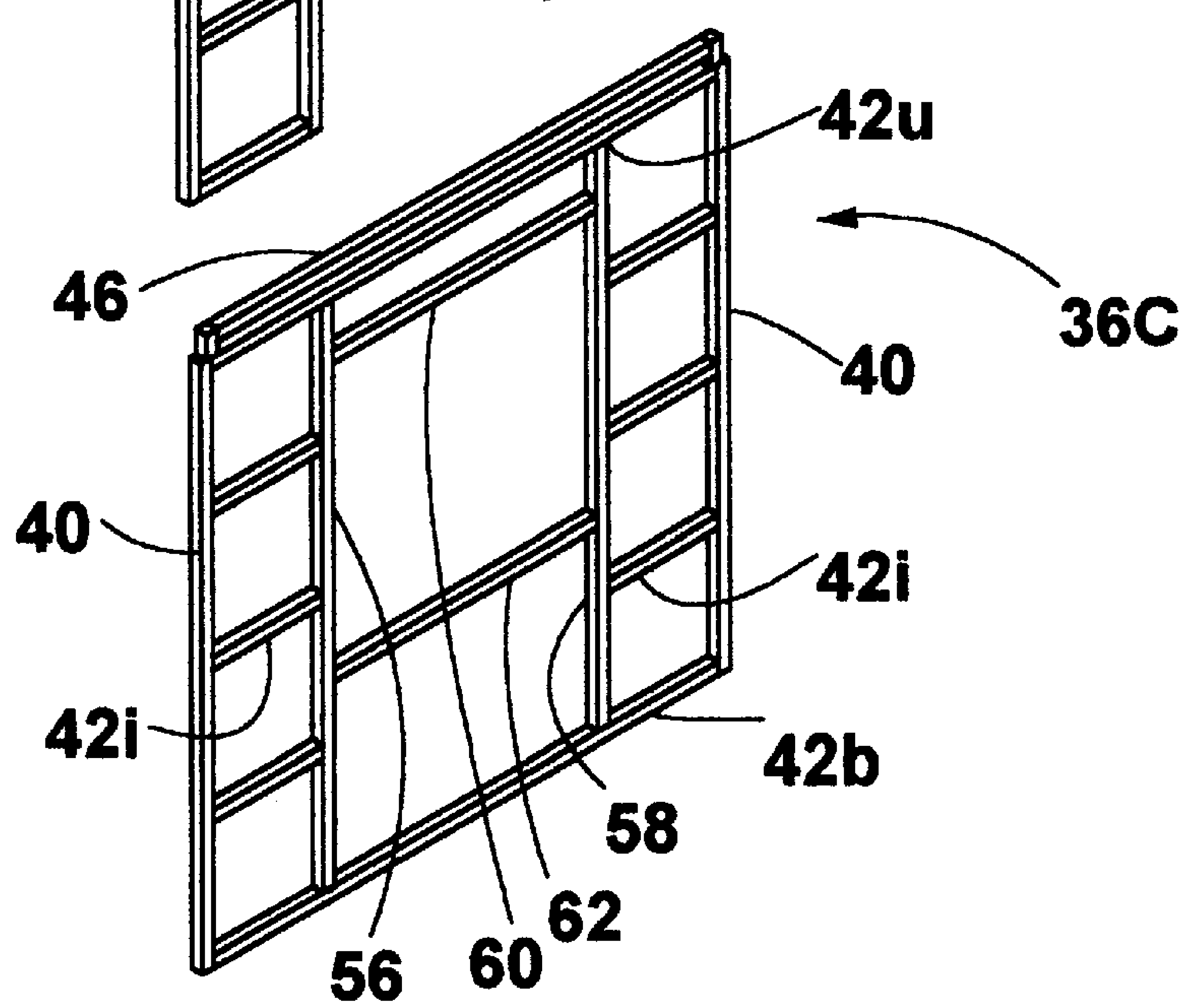


Fig. 3C

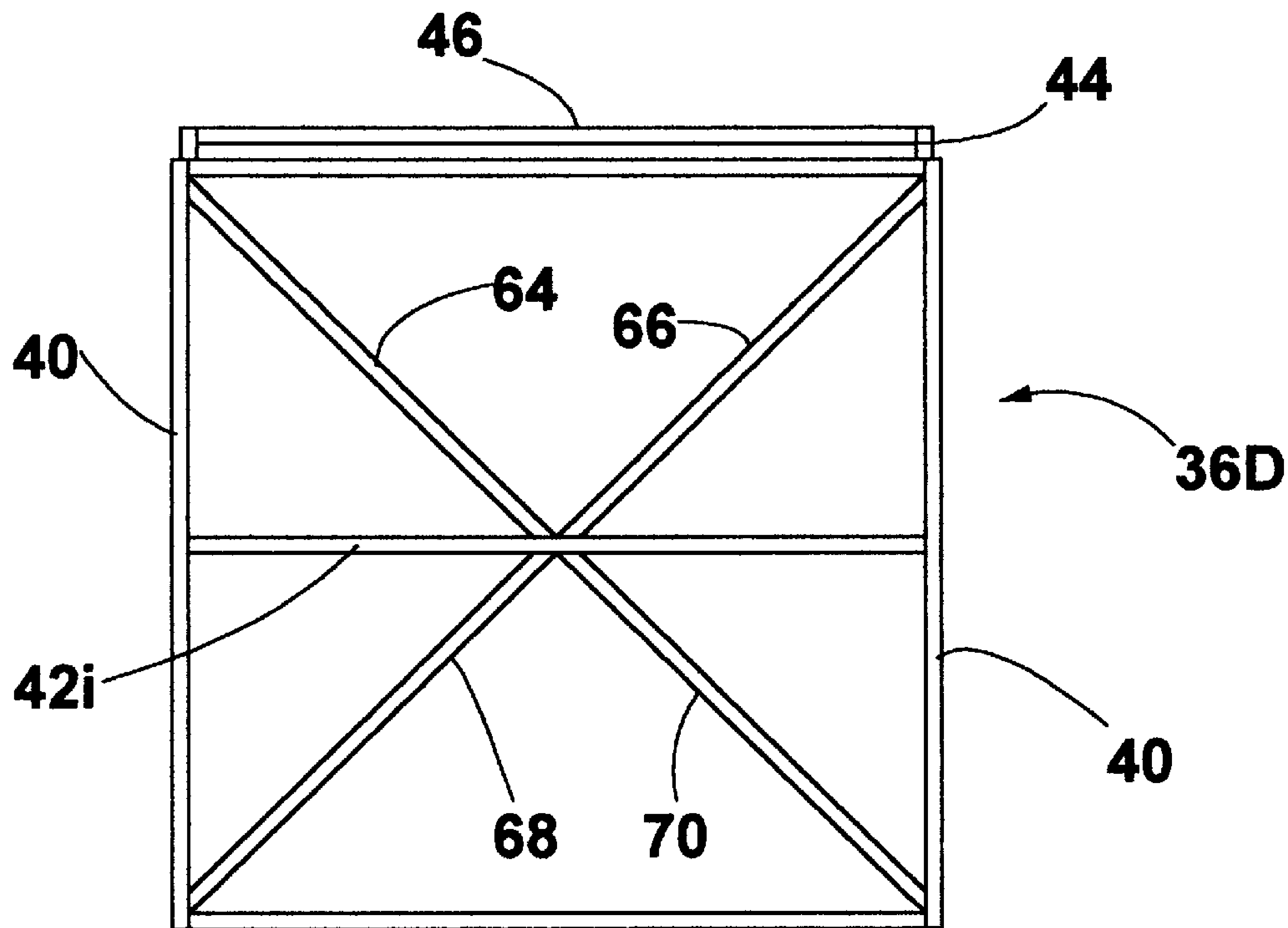


Fig. 3D

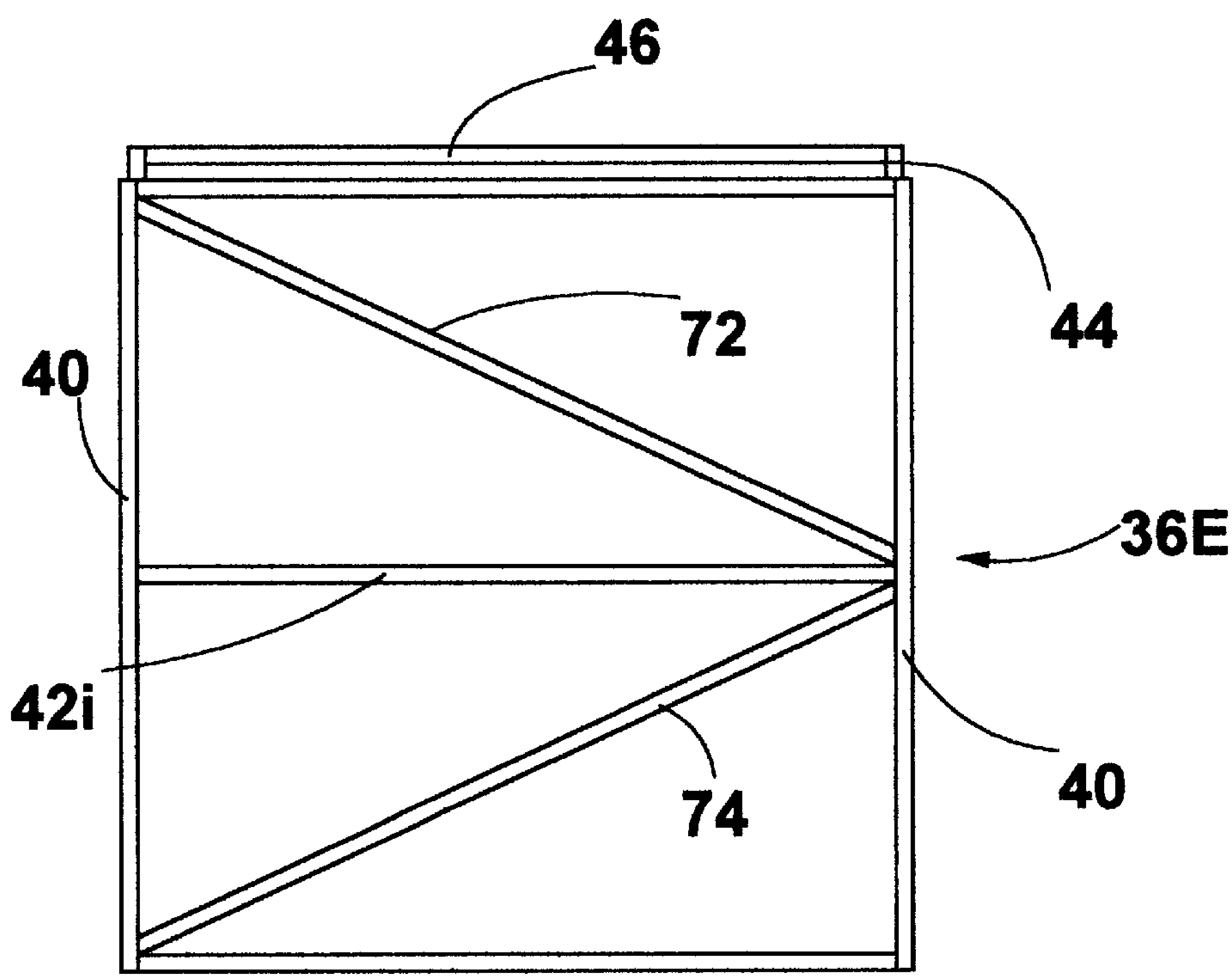


Fig. 3E

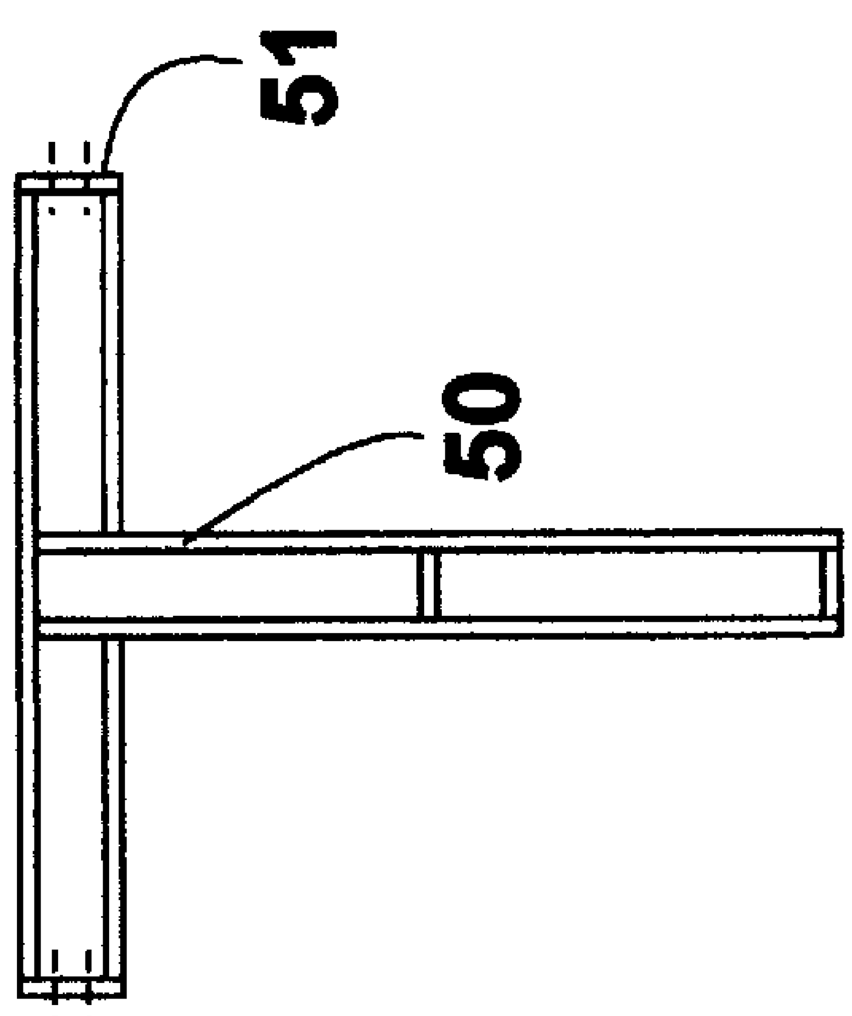
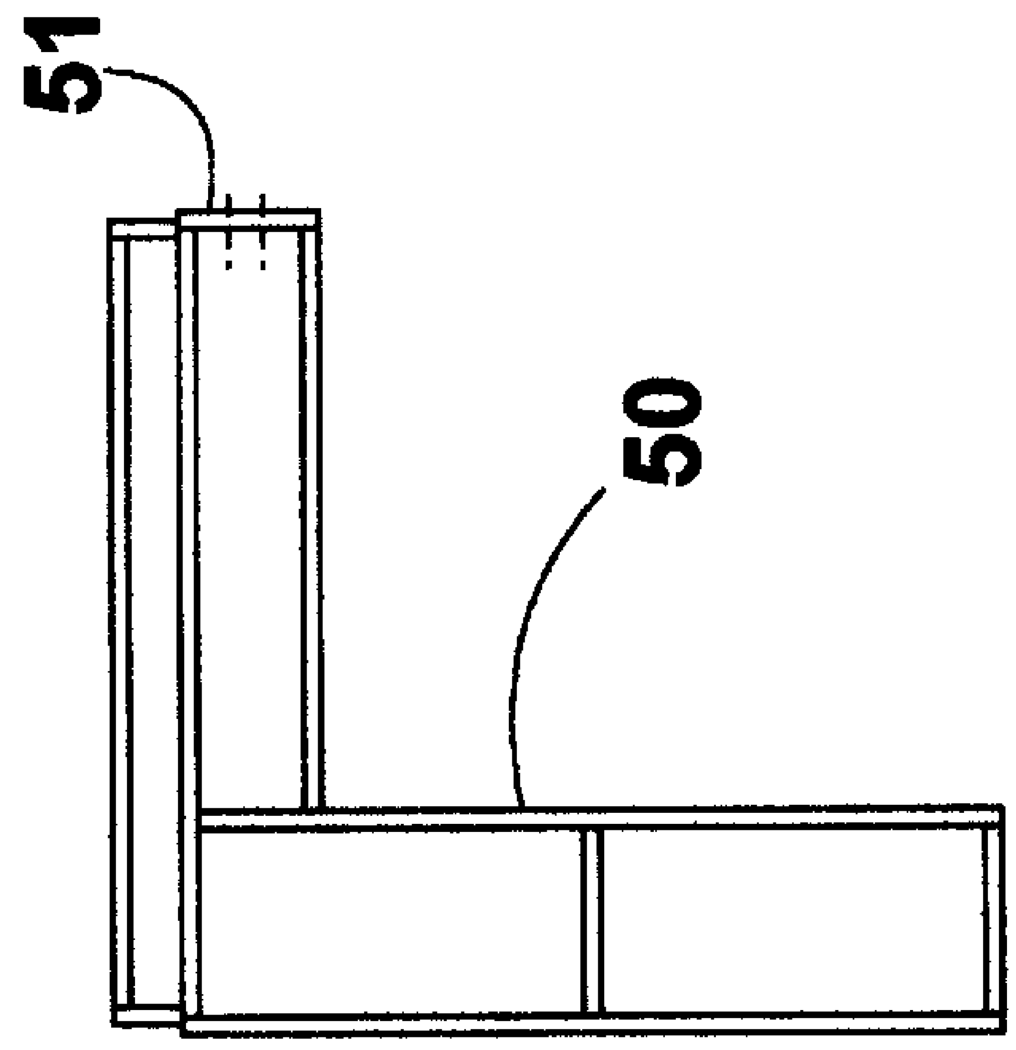


Fig. 3F



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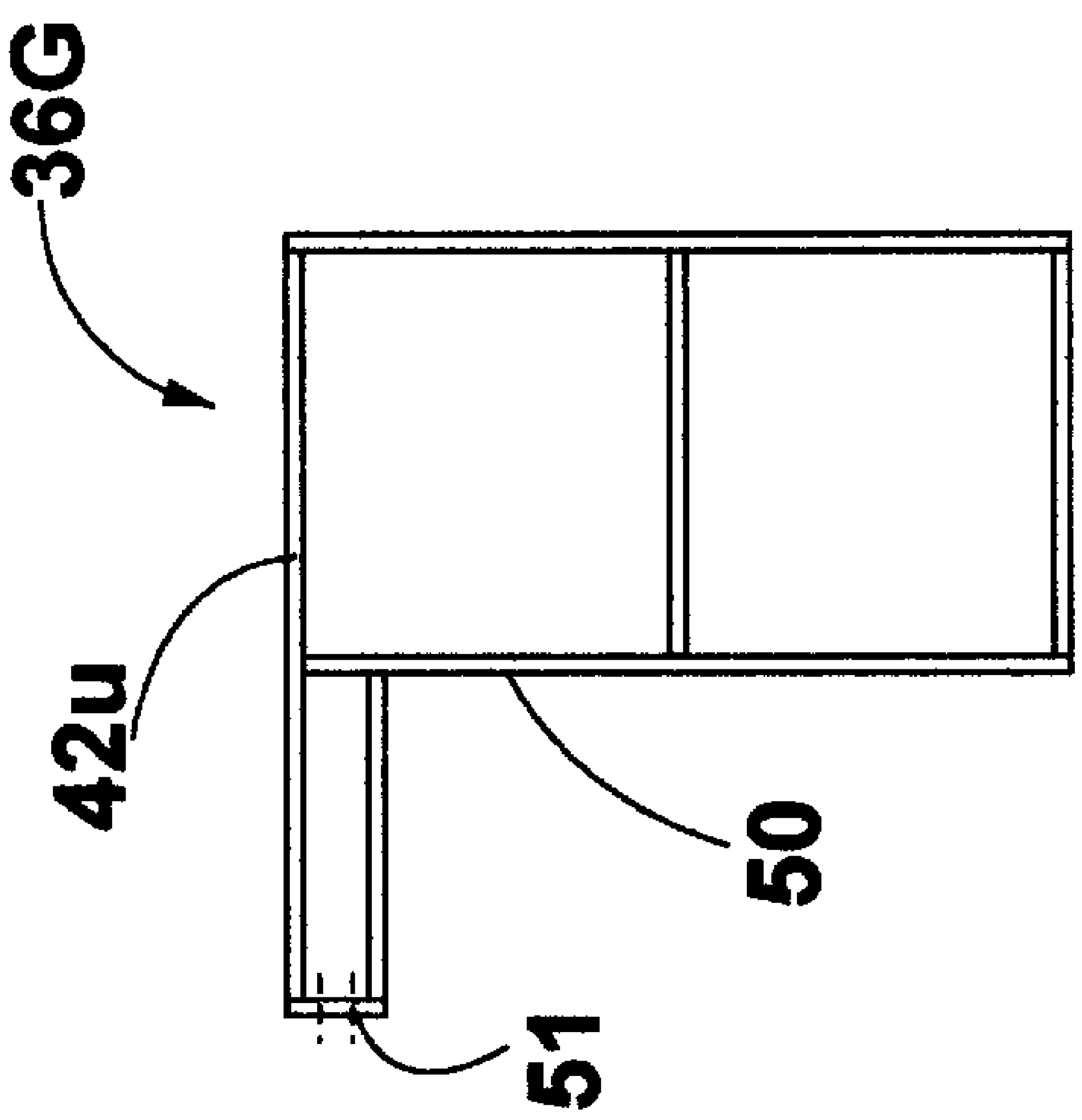

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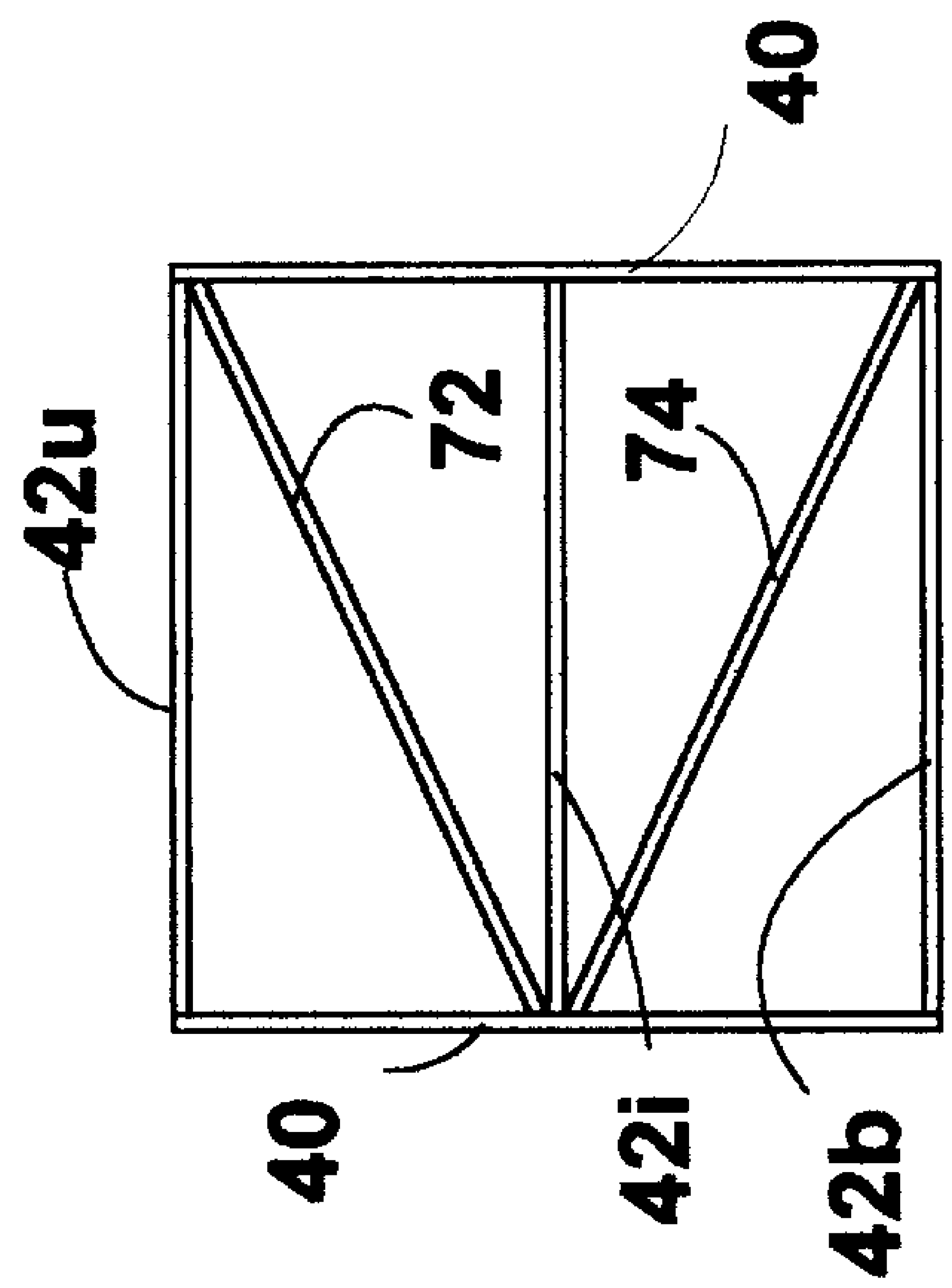


Fig. 3K

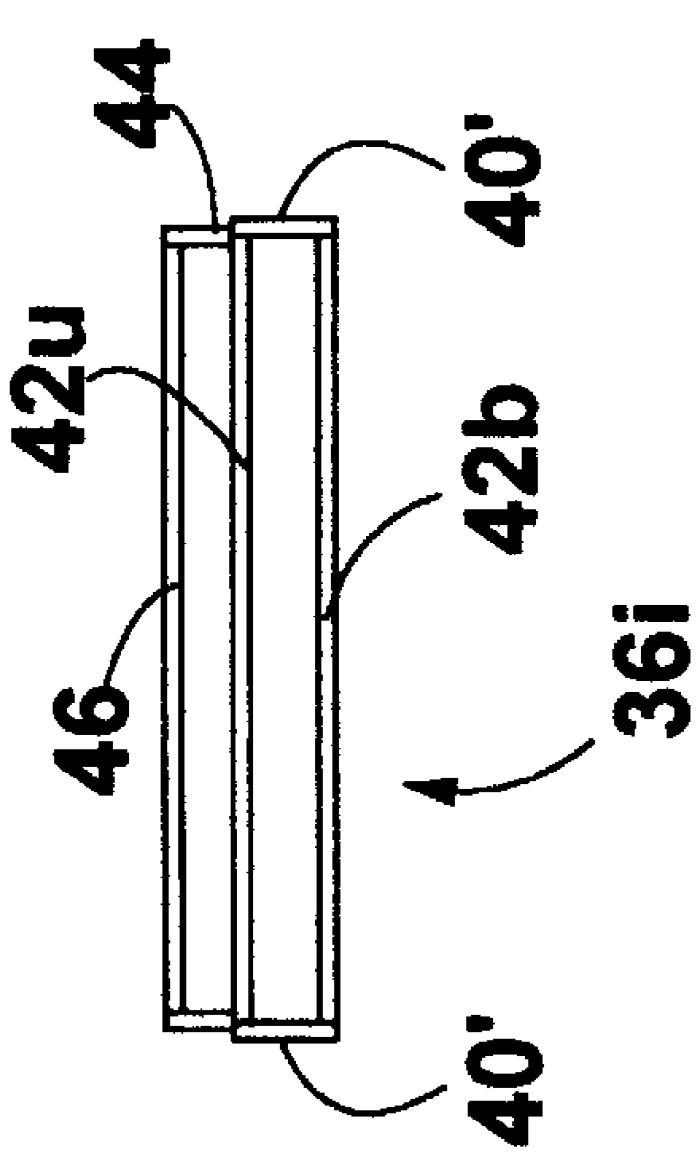


Fig. 3I

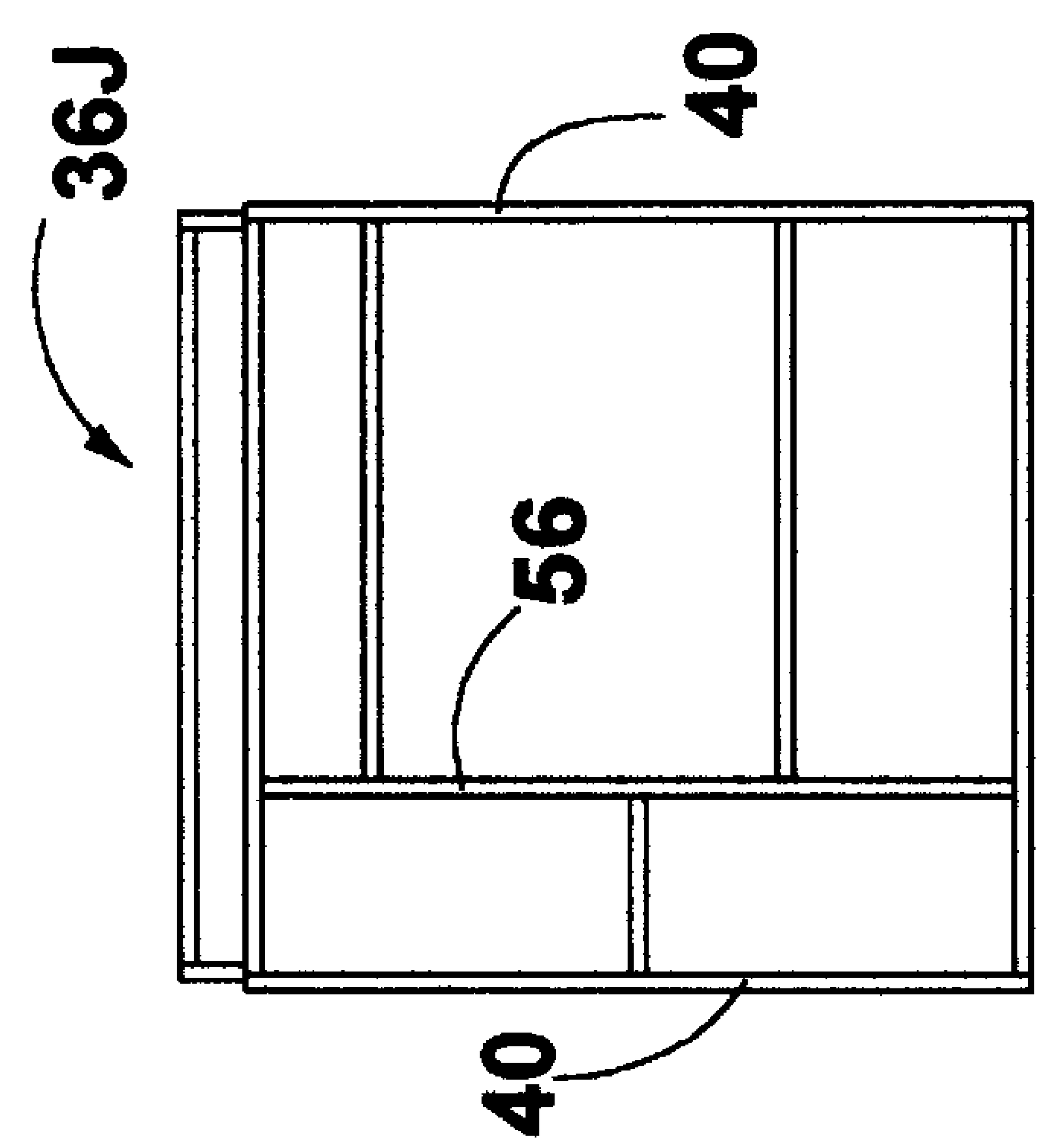


Fig. 3J

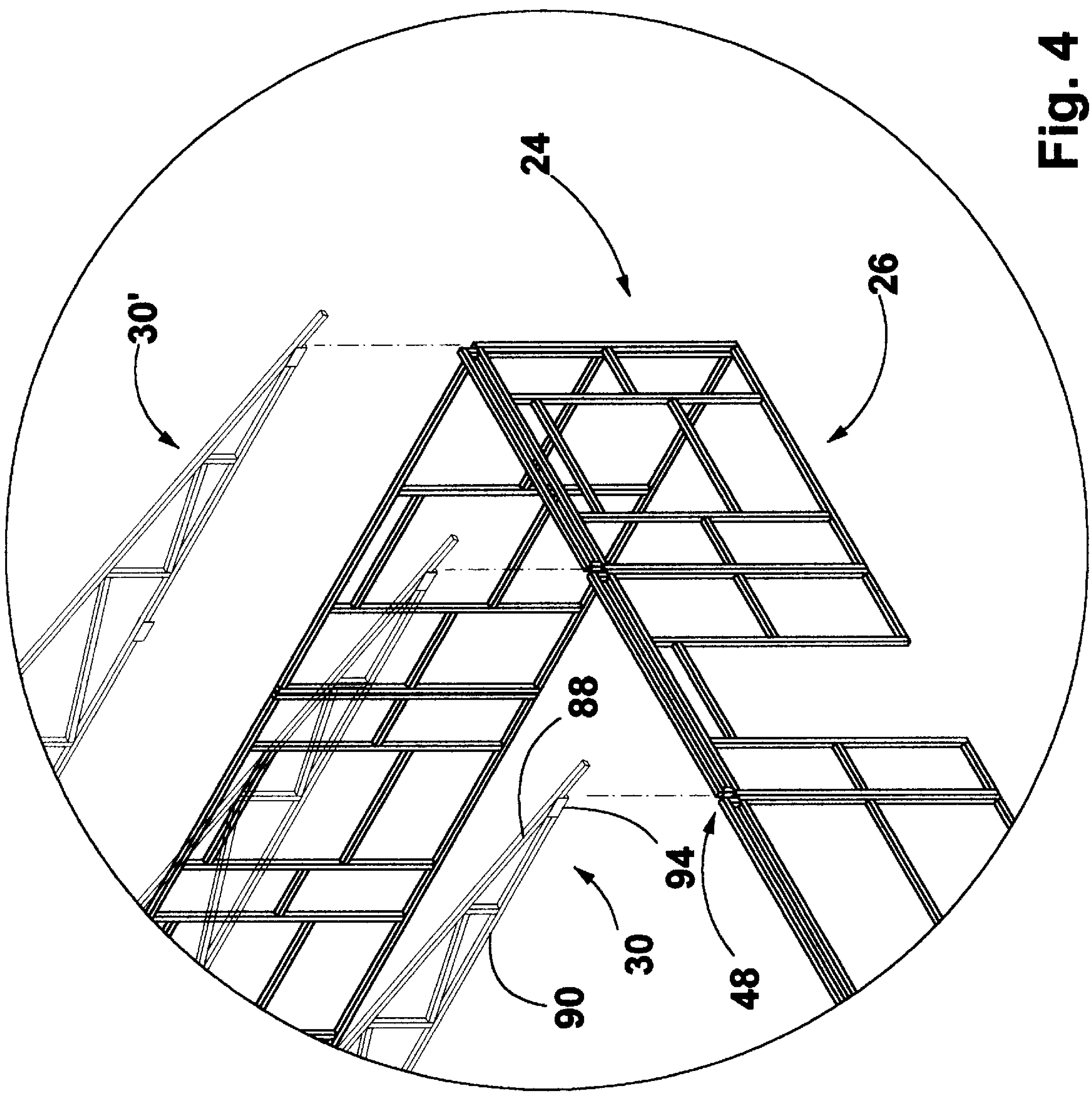


Fig. 4

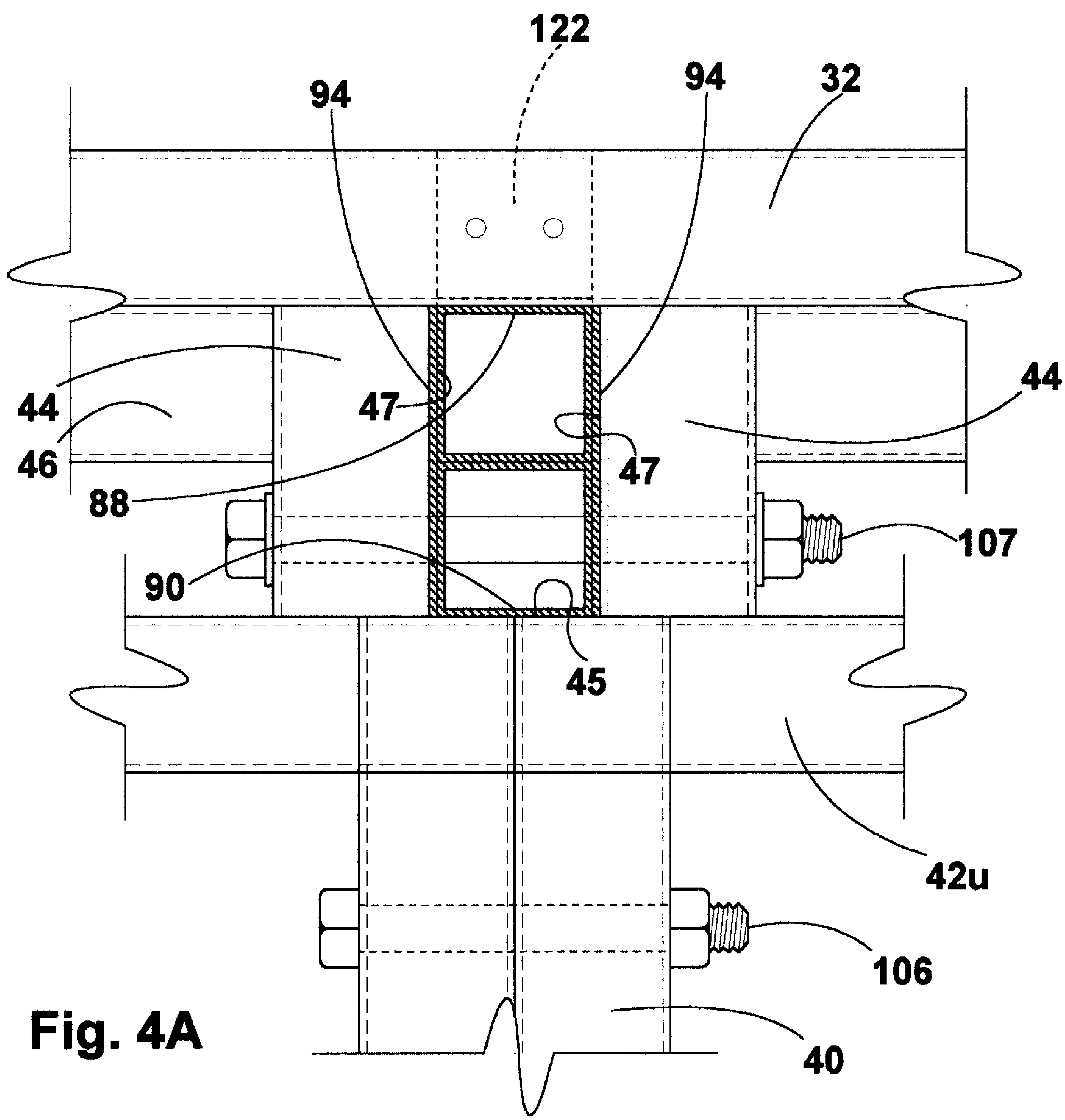


Fig. 4A

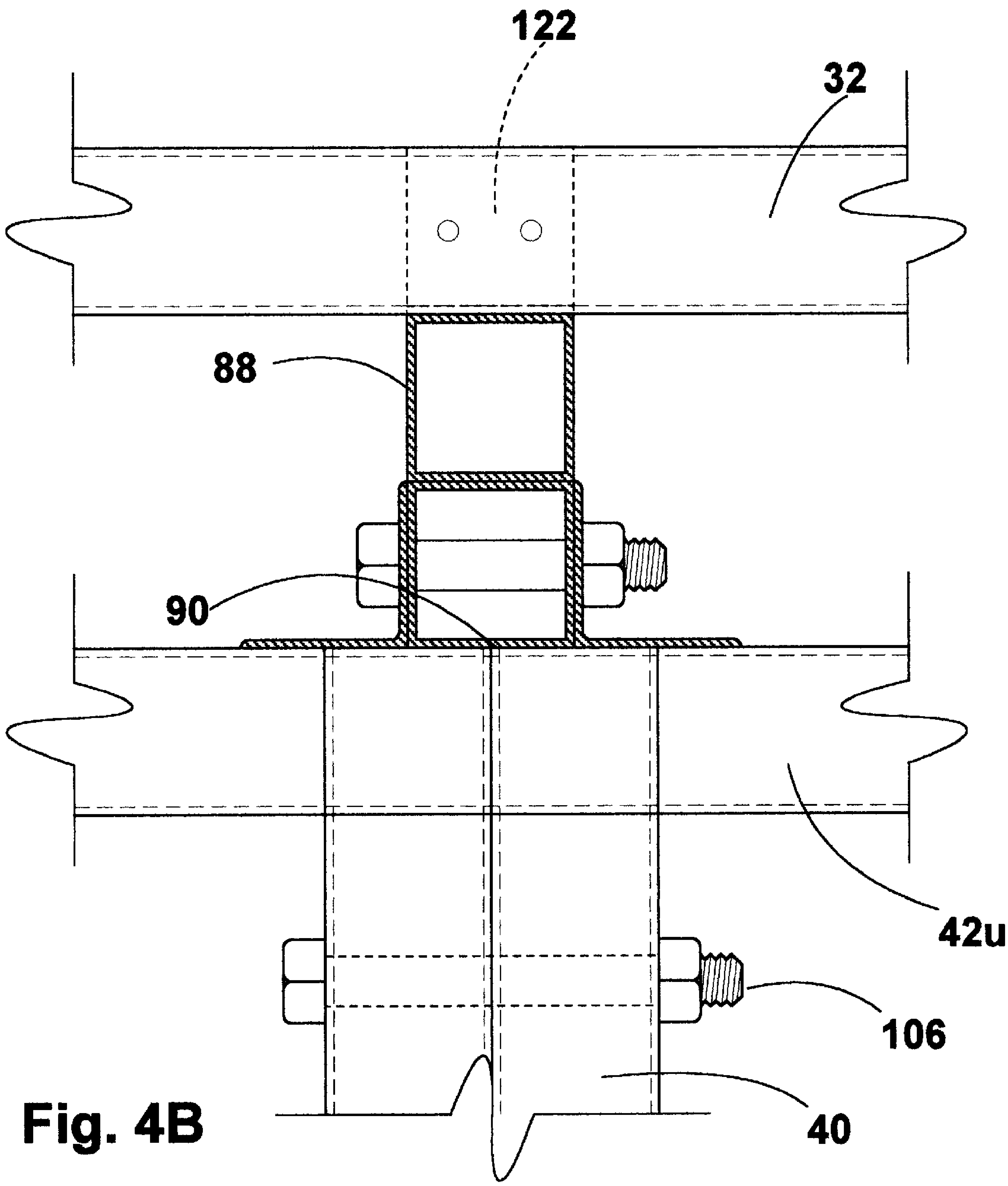


Fig. 4B

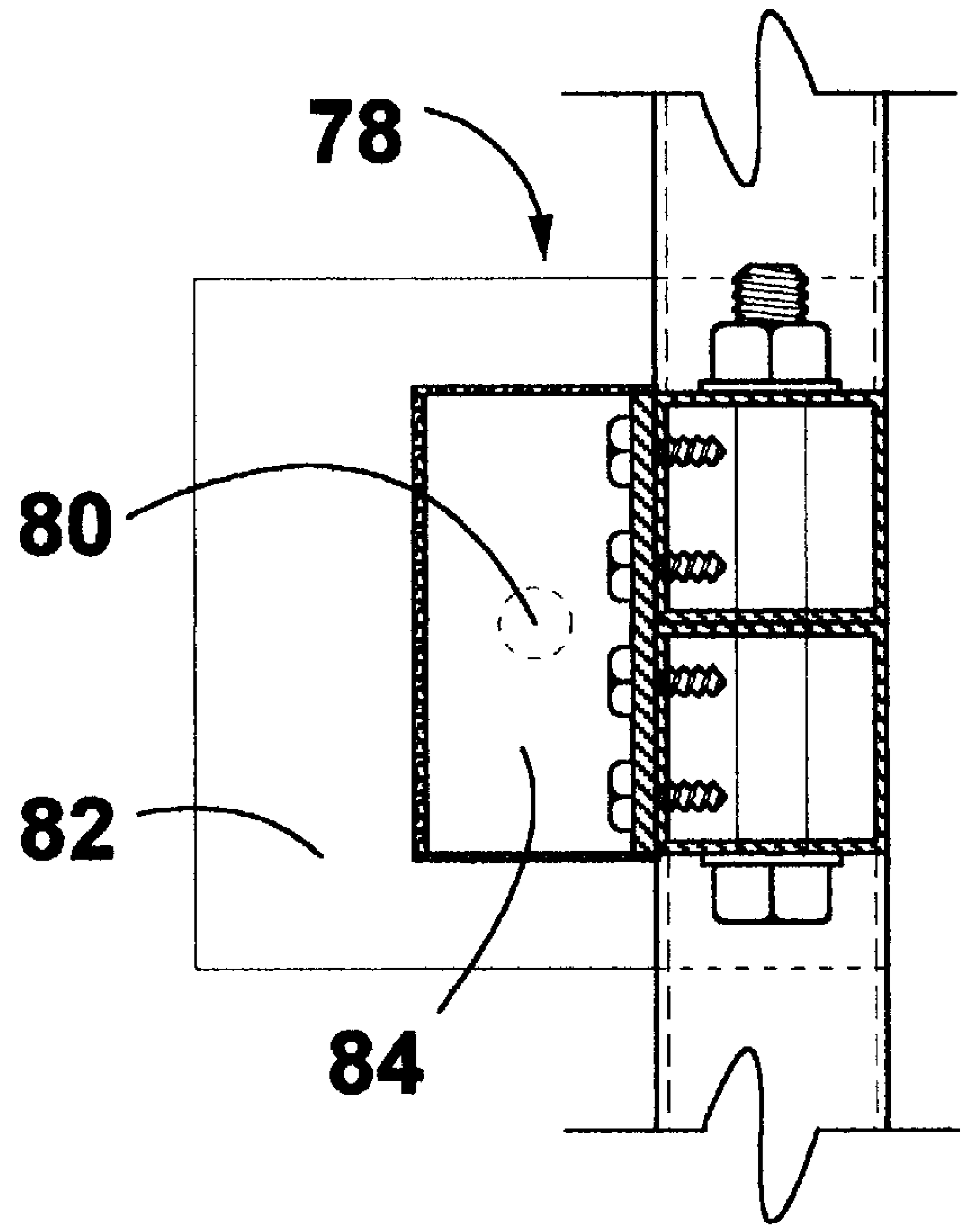
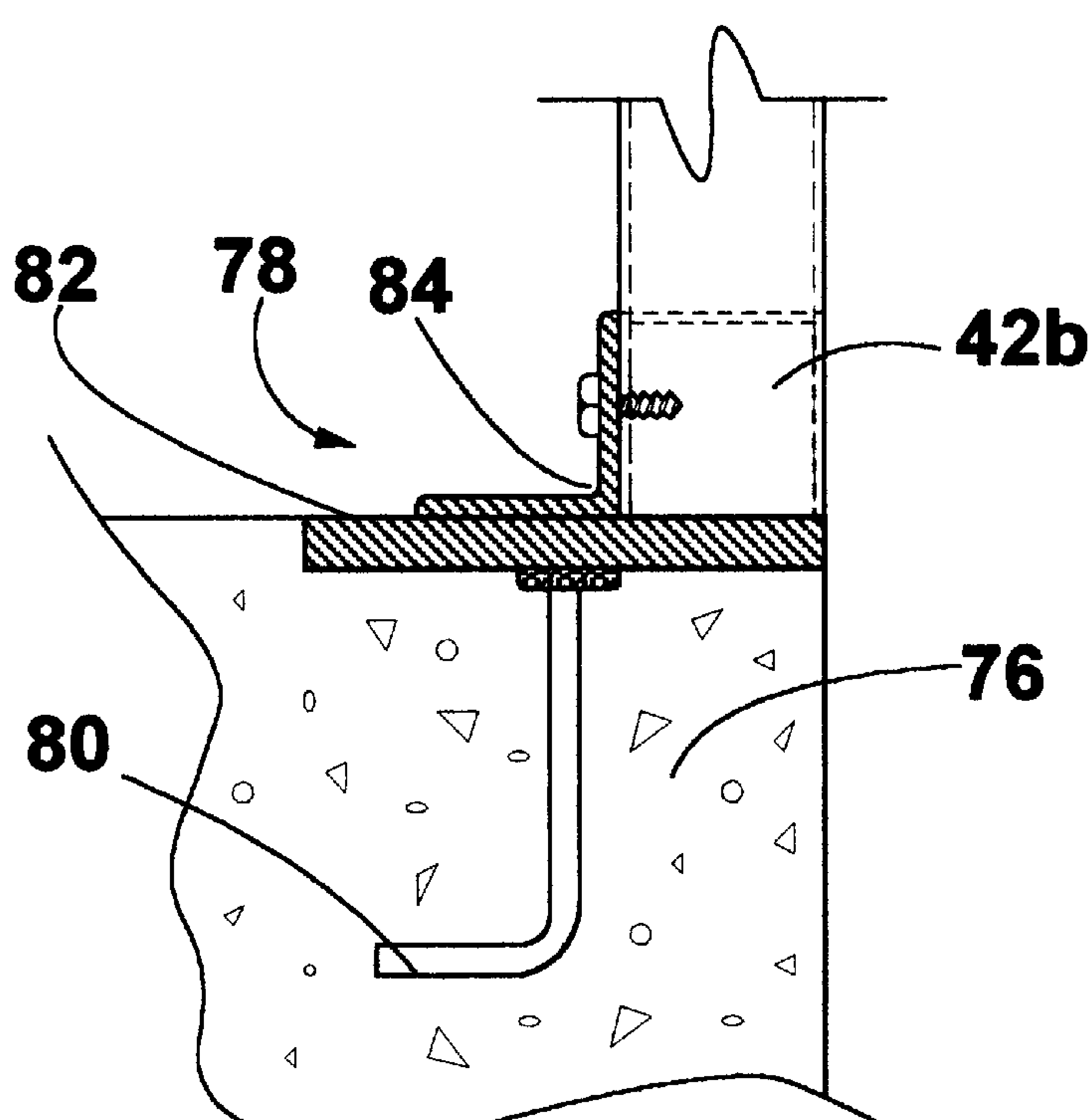


Fig. 5



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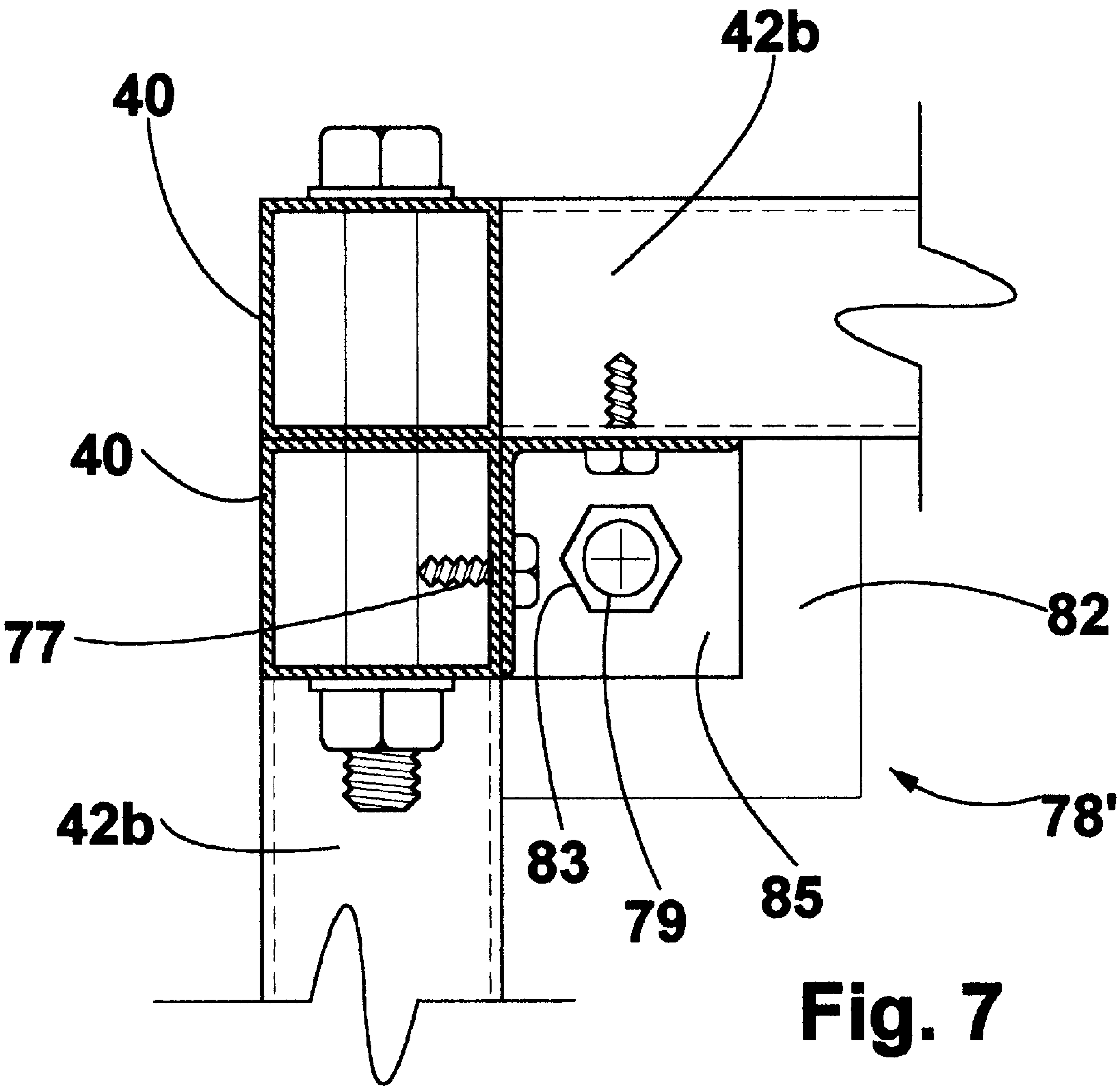

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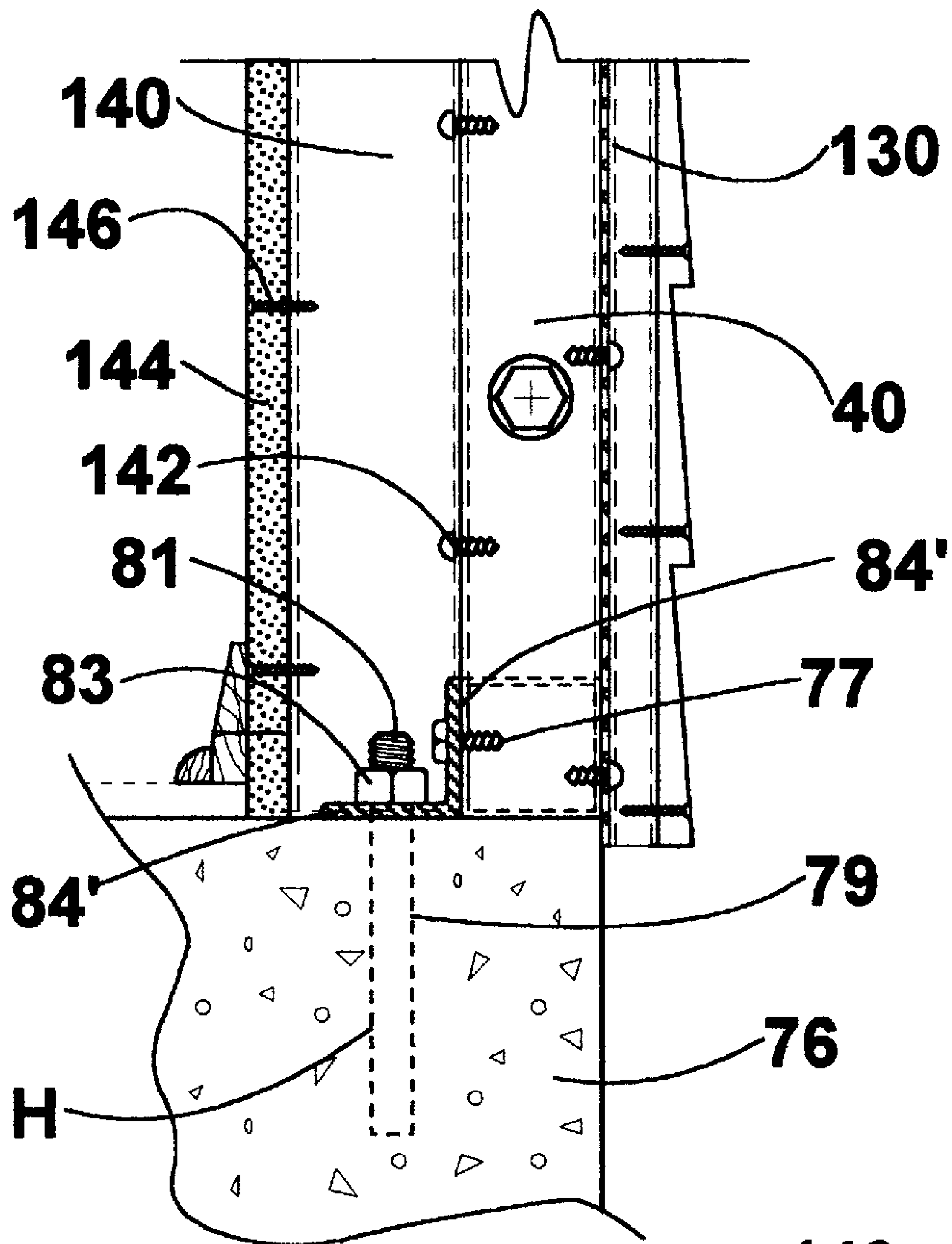

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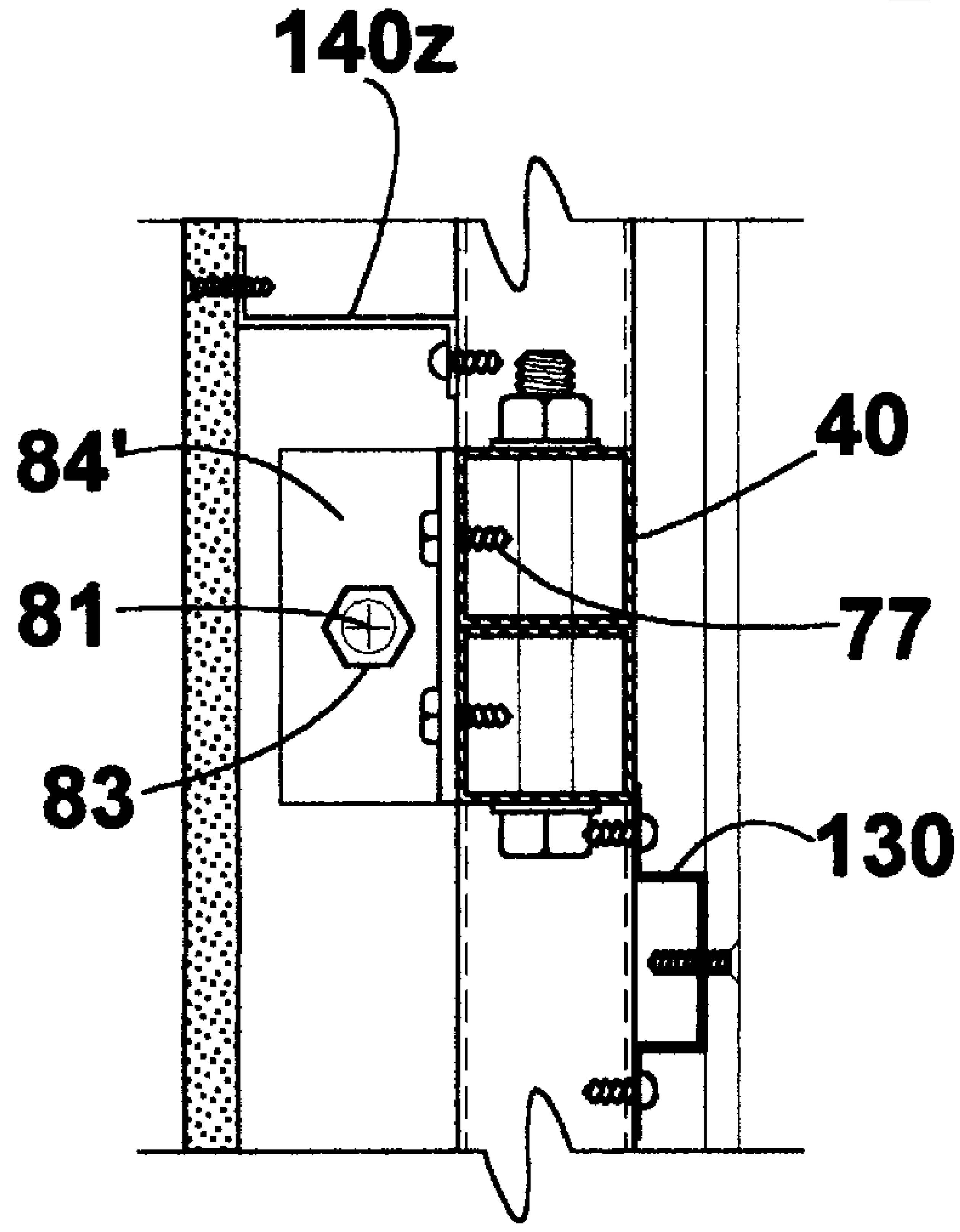


Fig. 9A

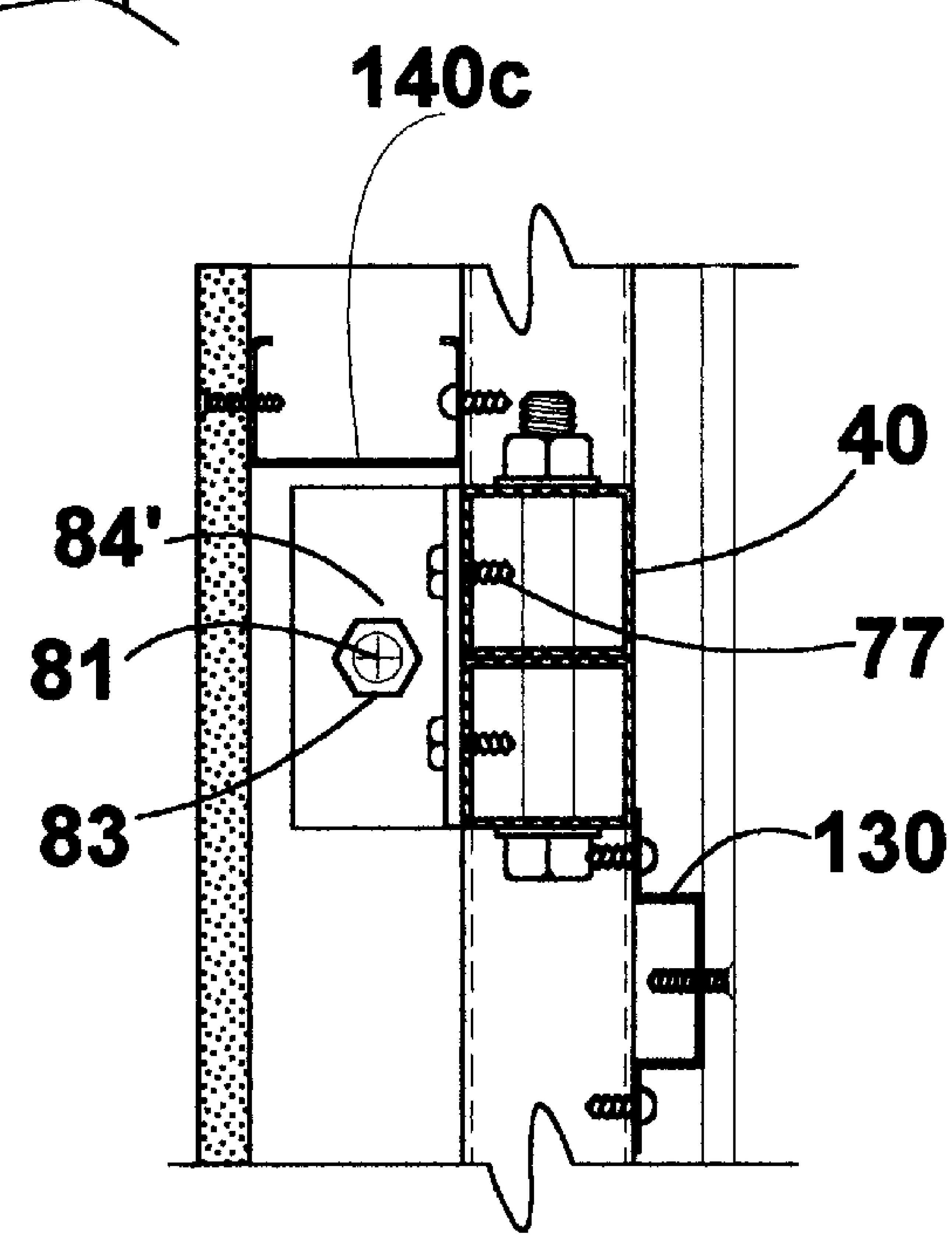


Fig. 9B

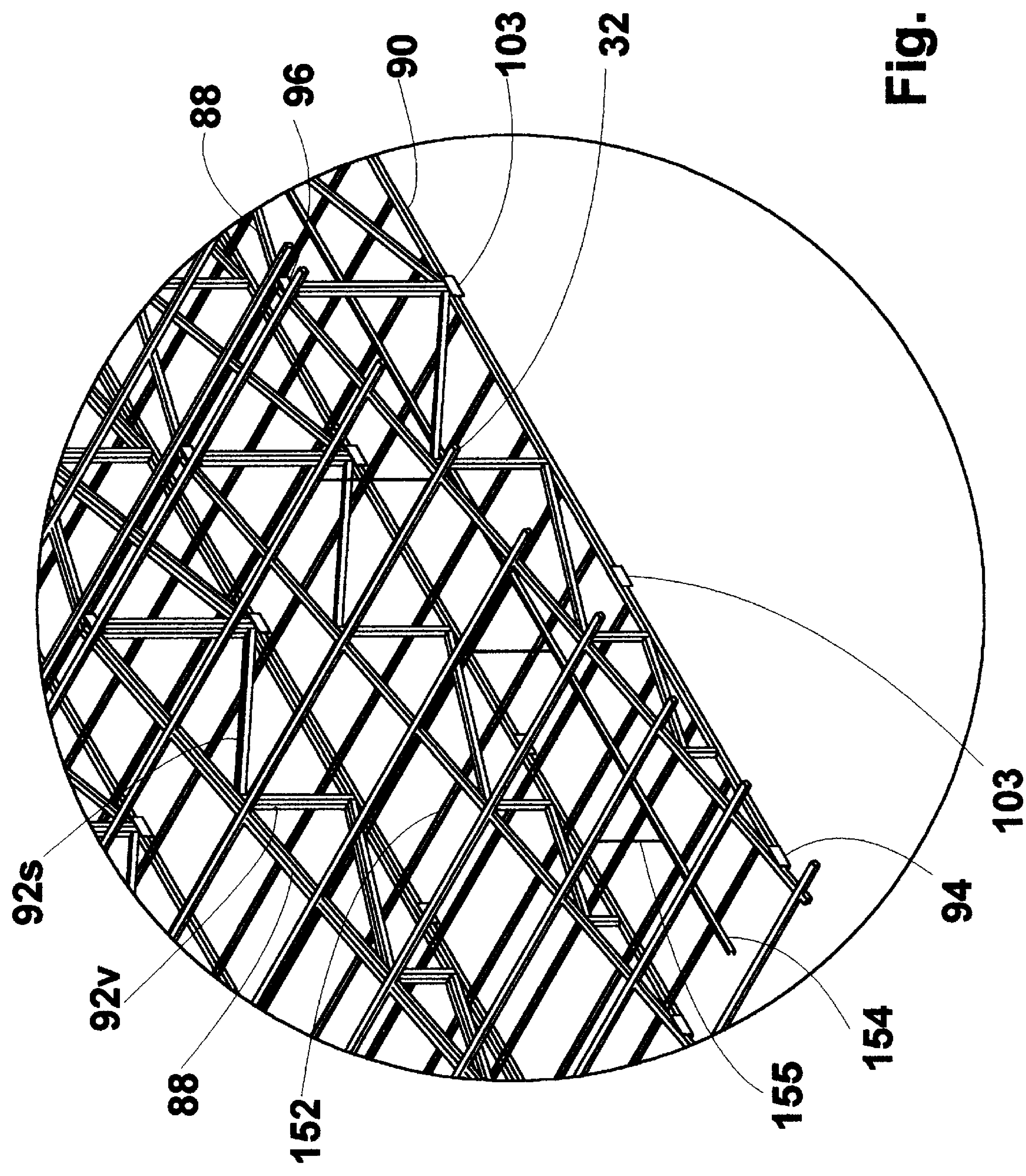
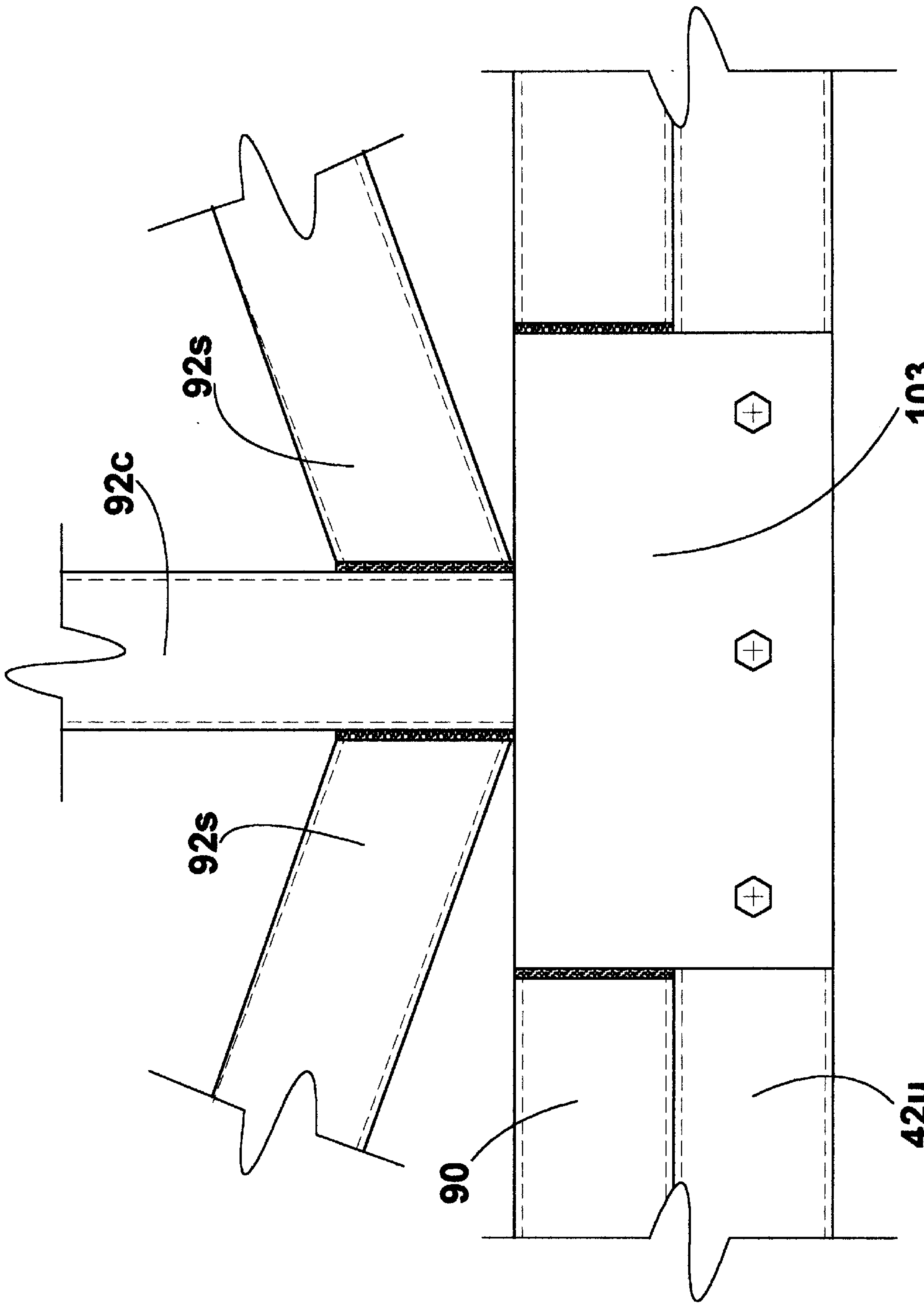


Fig. 10



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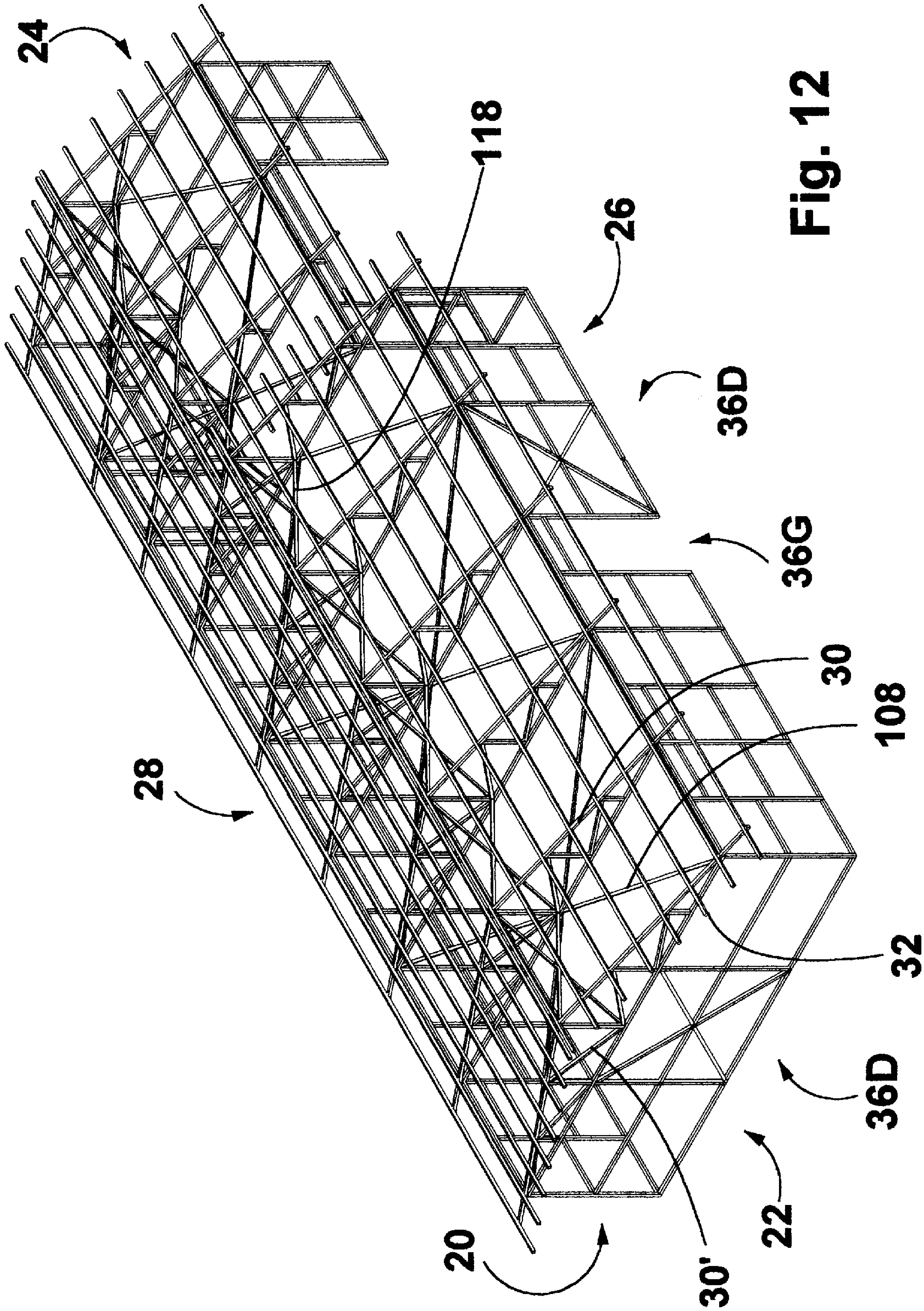

Fig. 12

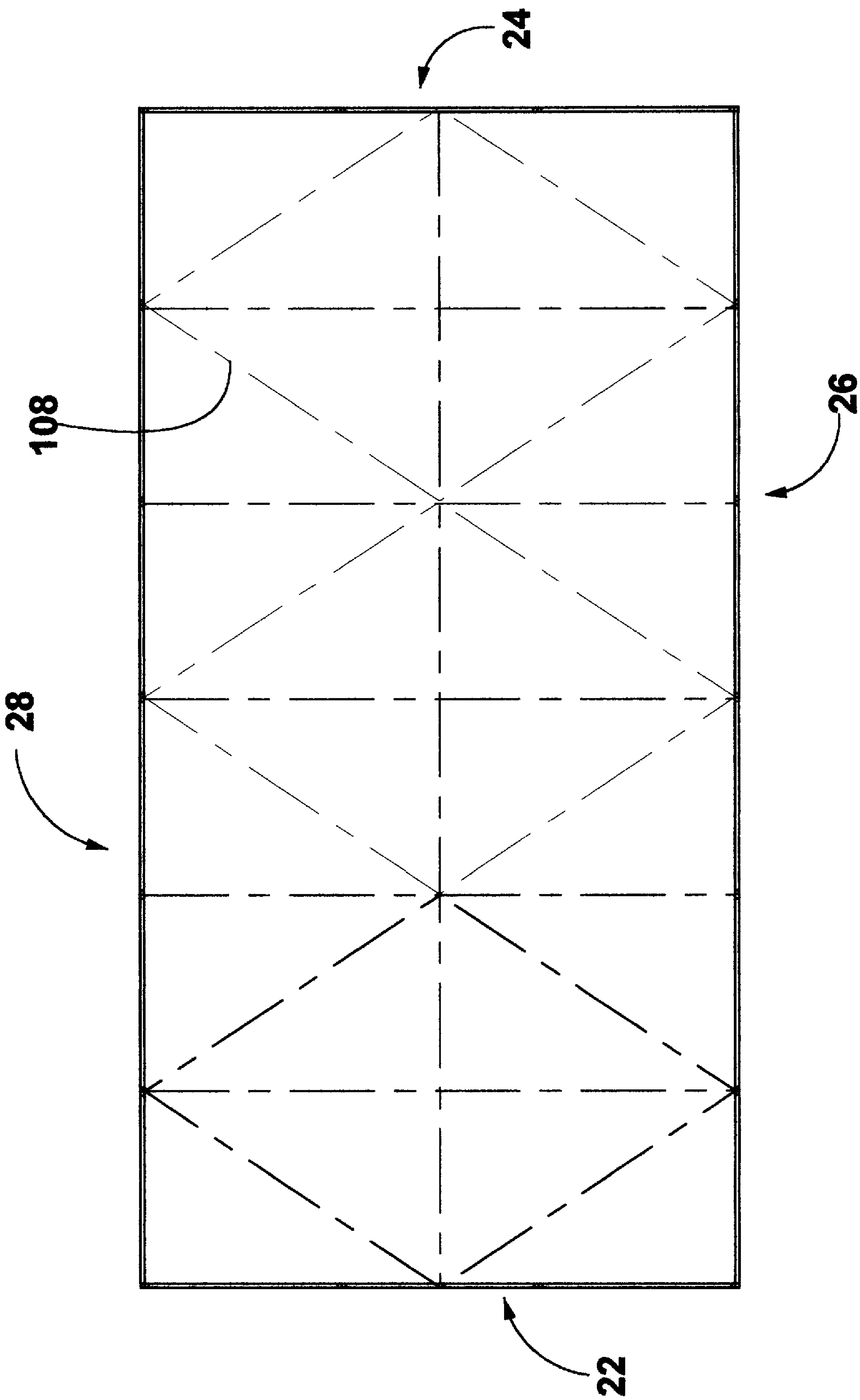

Fig. 13

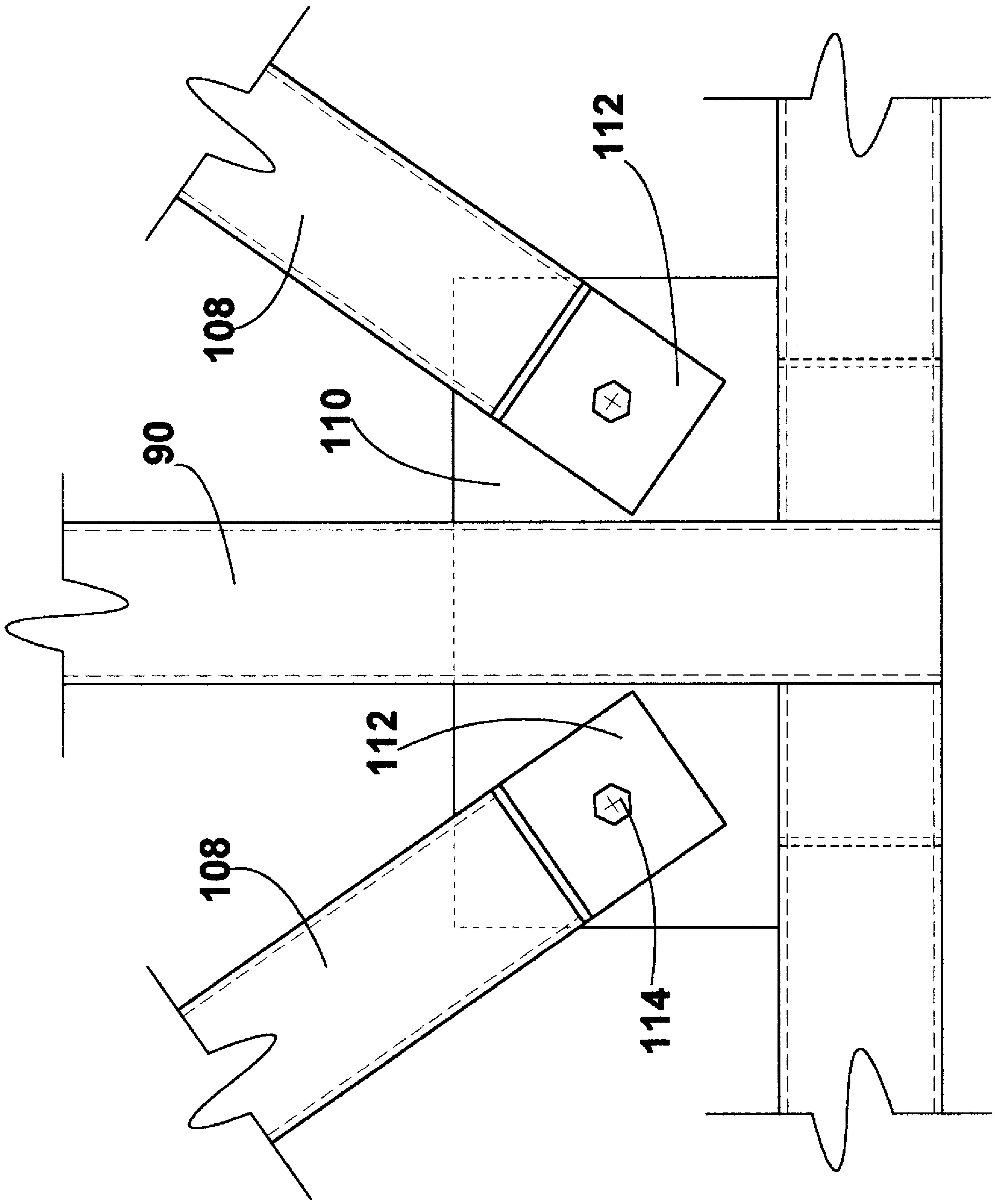

Fig. 14

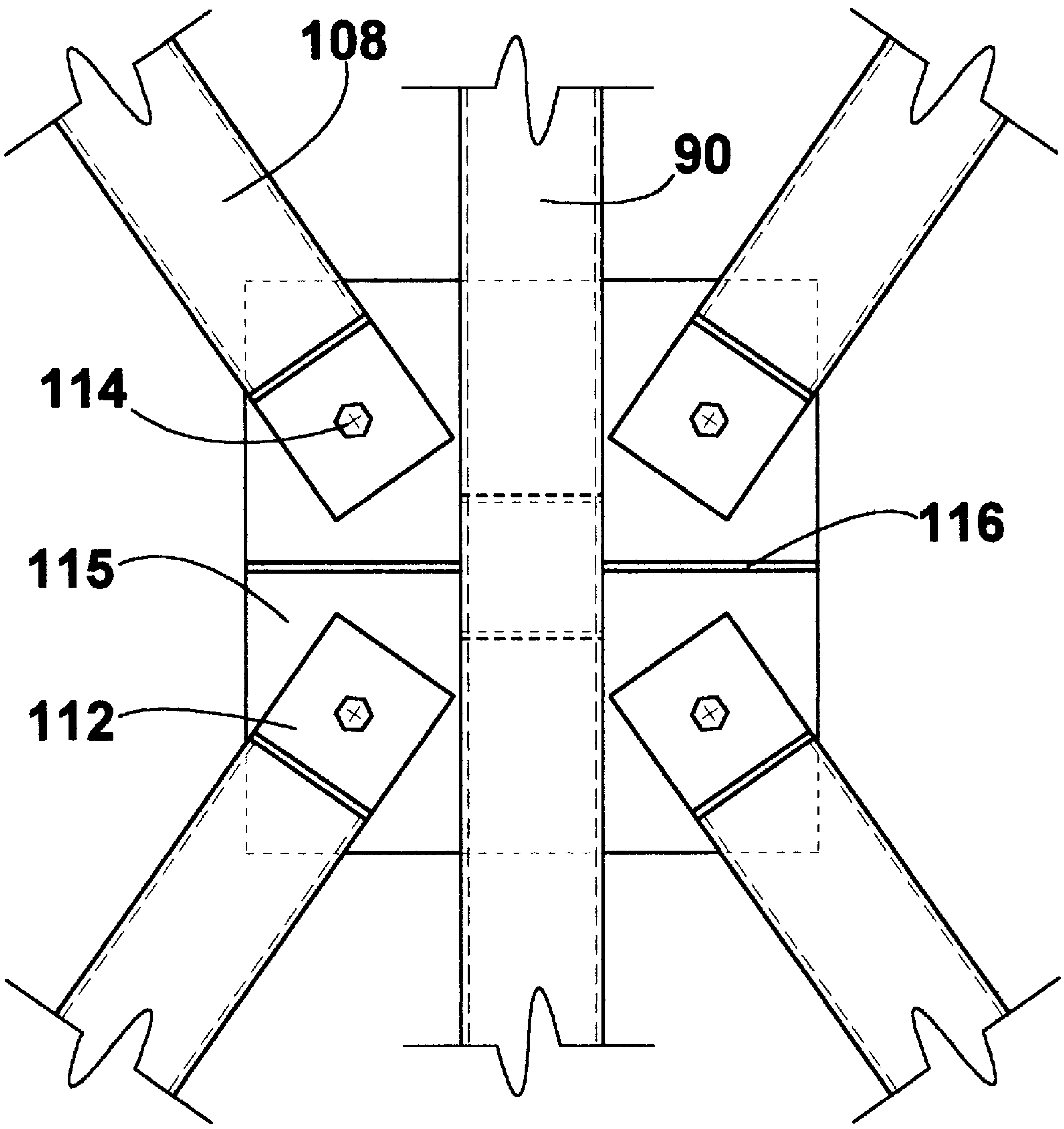

Fig. 15

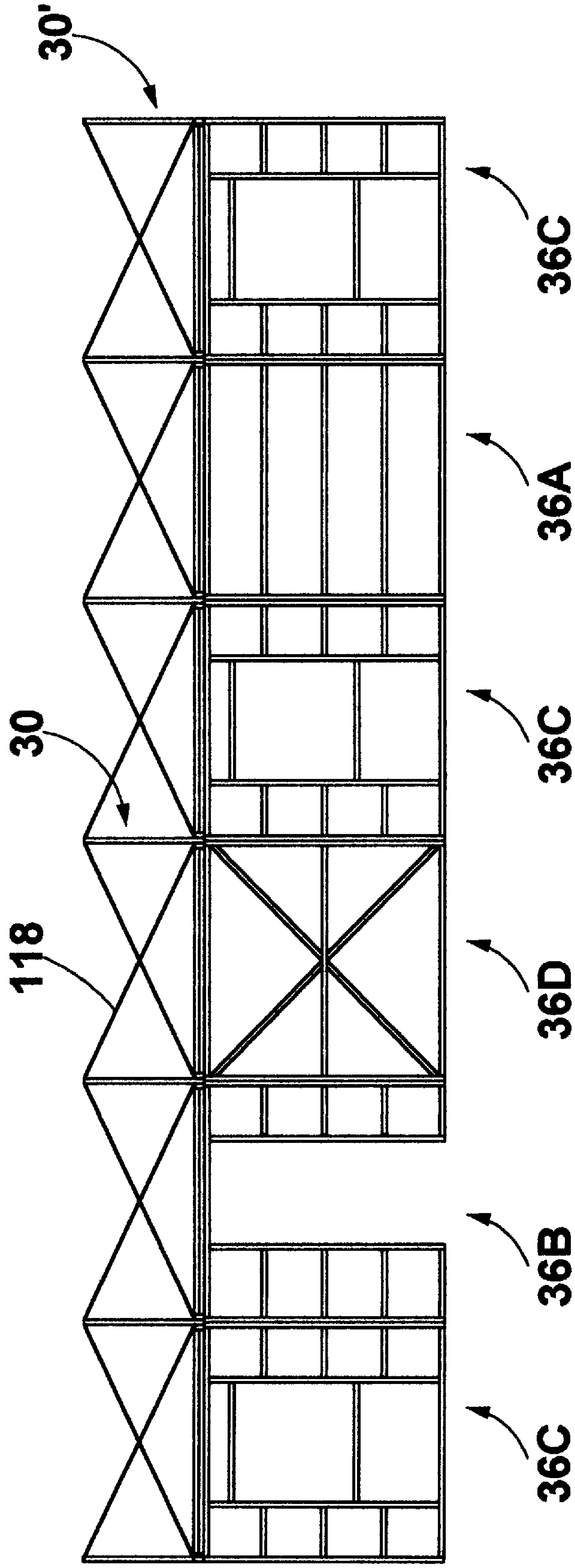

Fig. 16

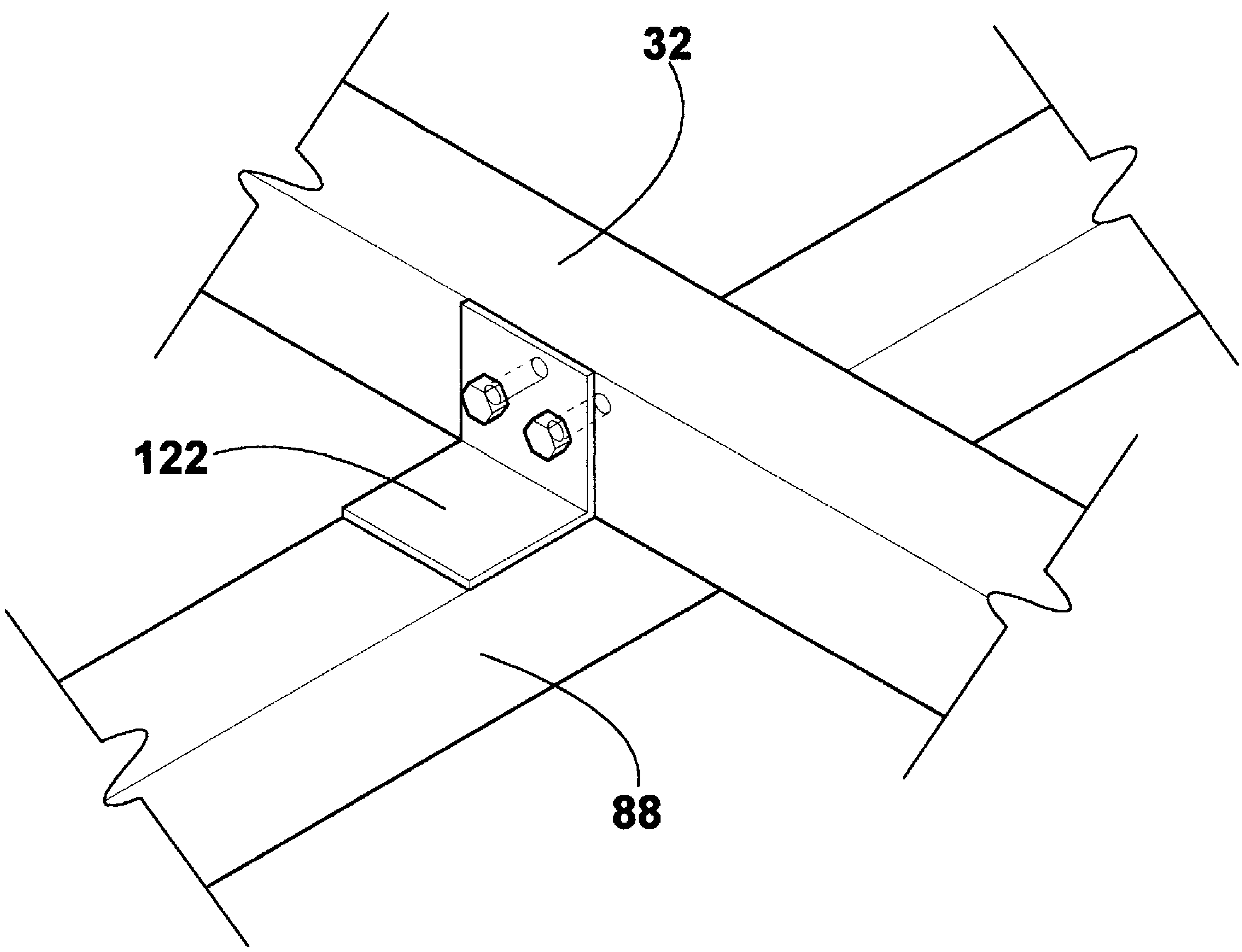

Fig. 17

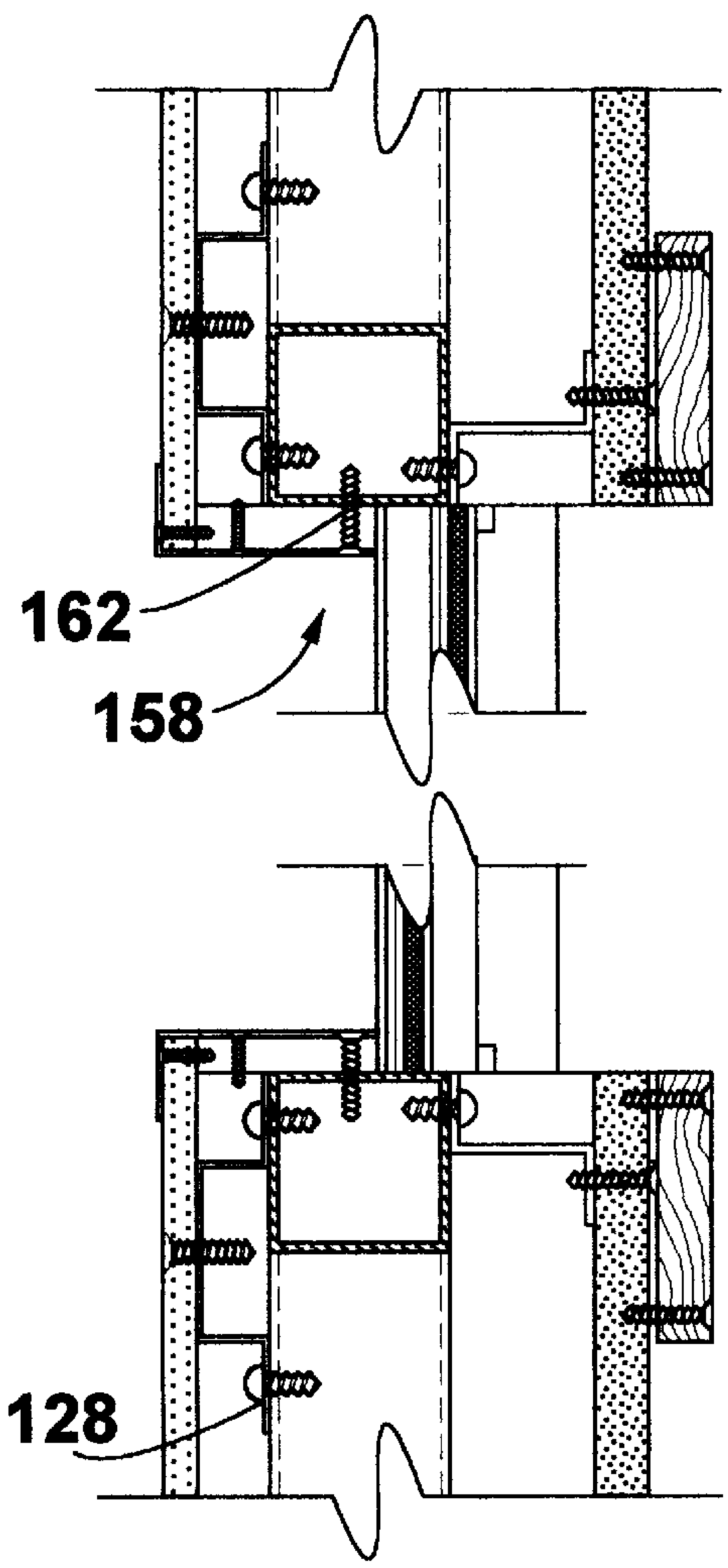

Fig. 18

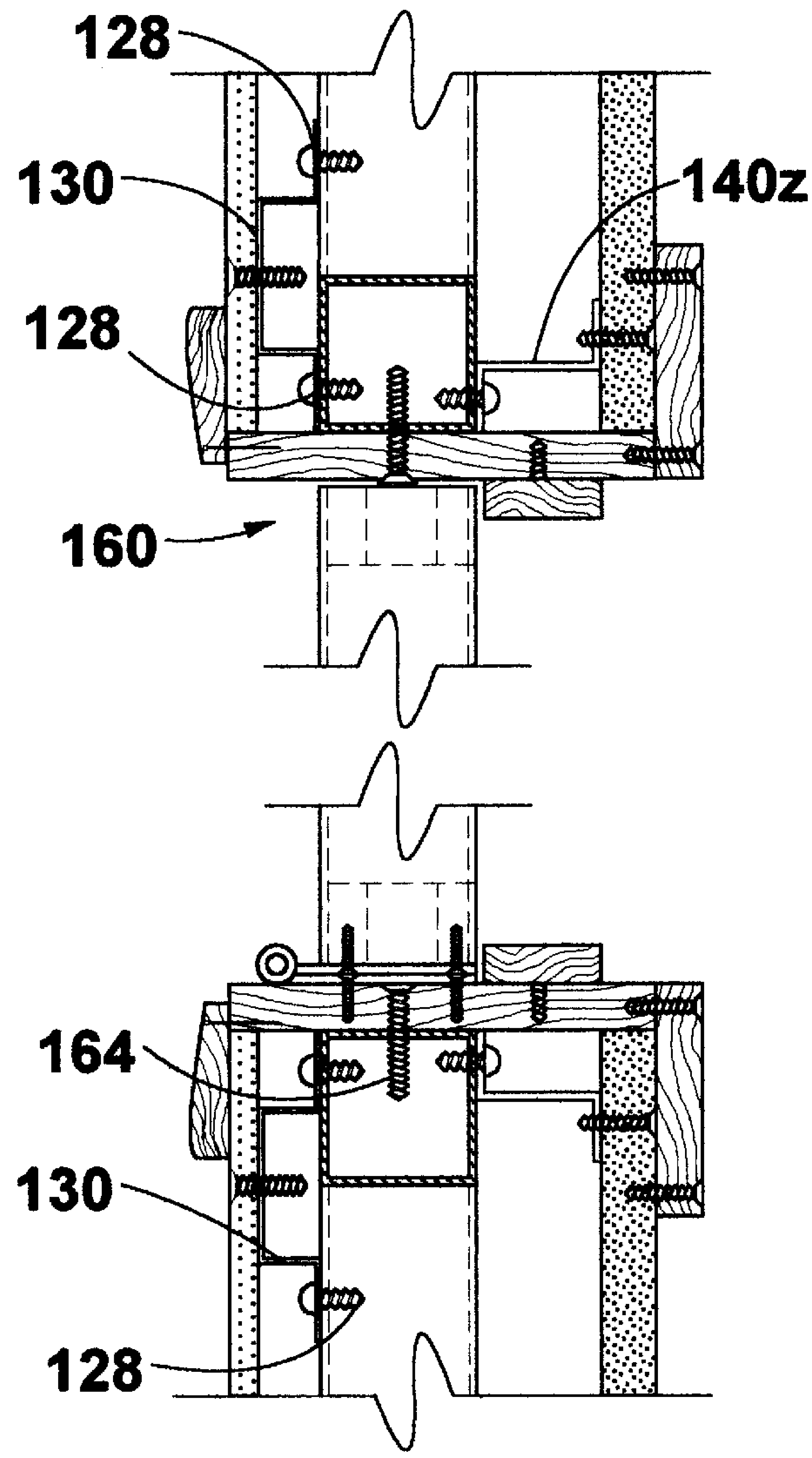

Fig. 19

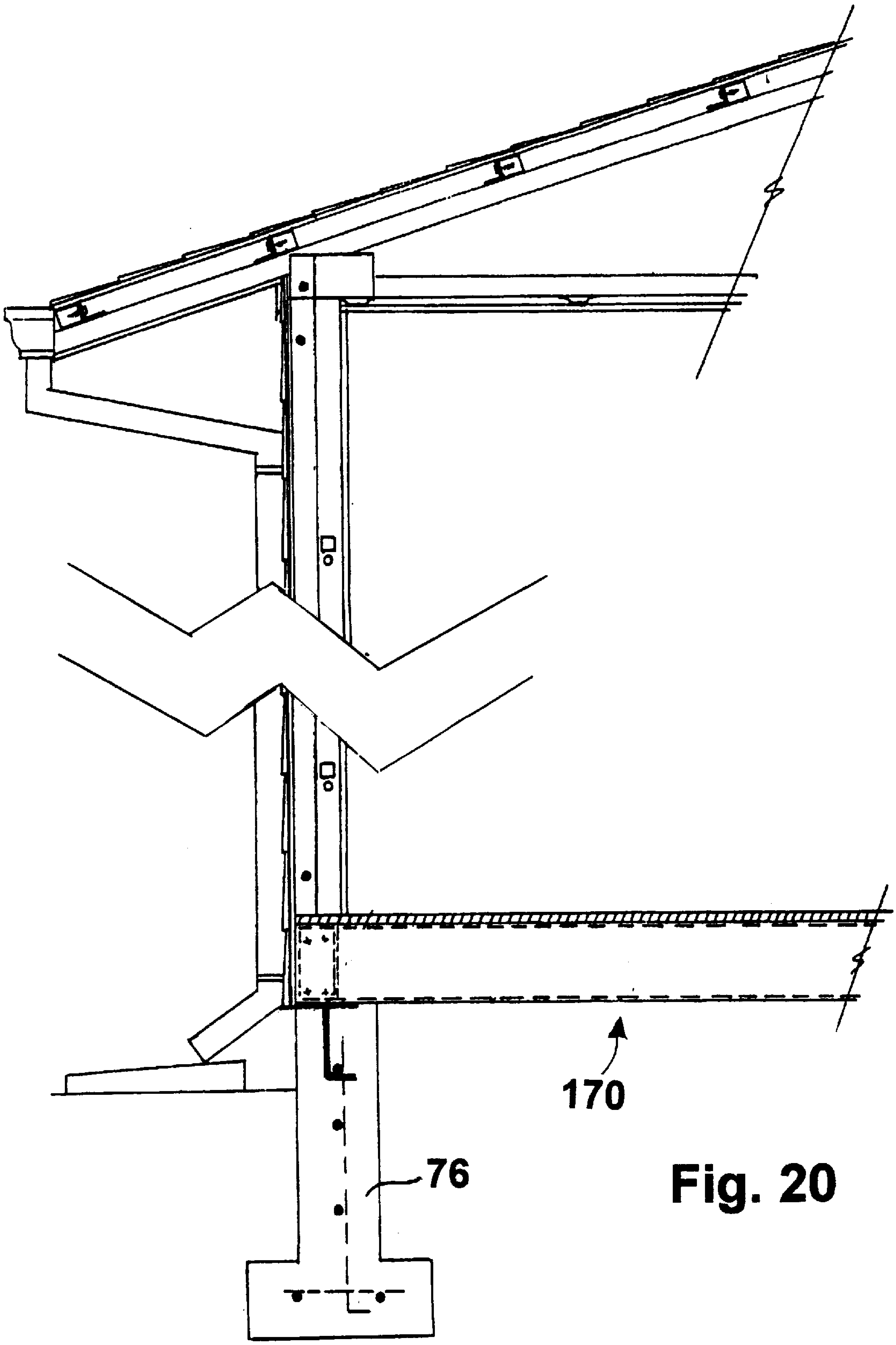

Fig. 20

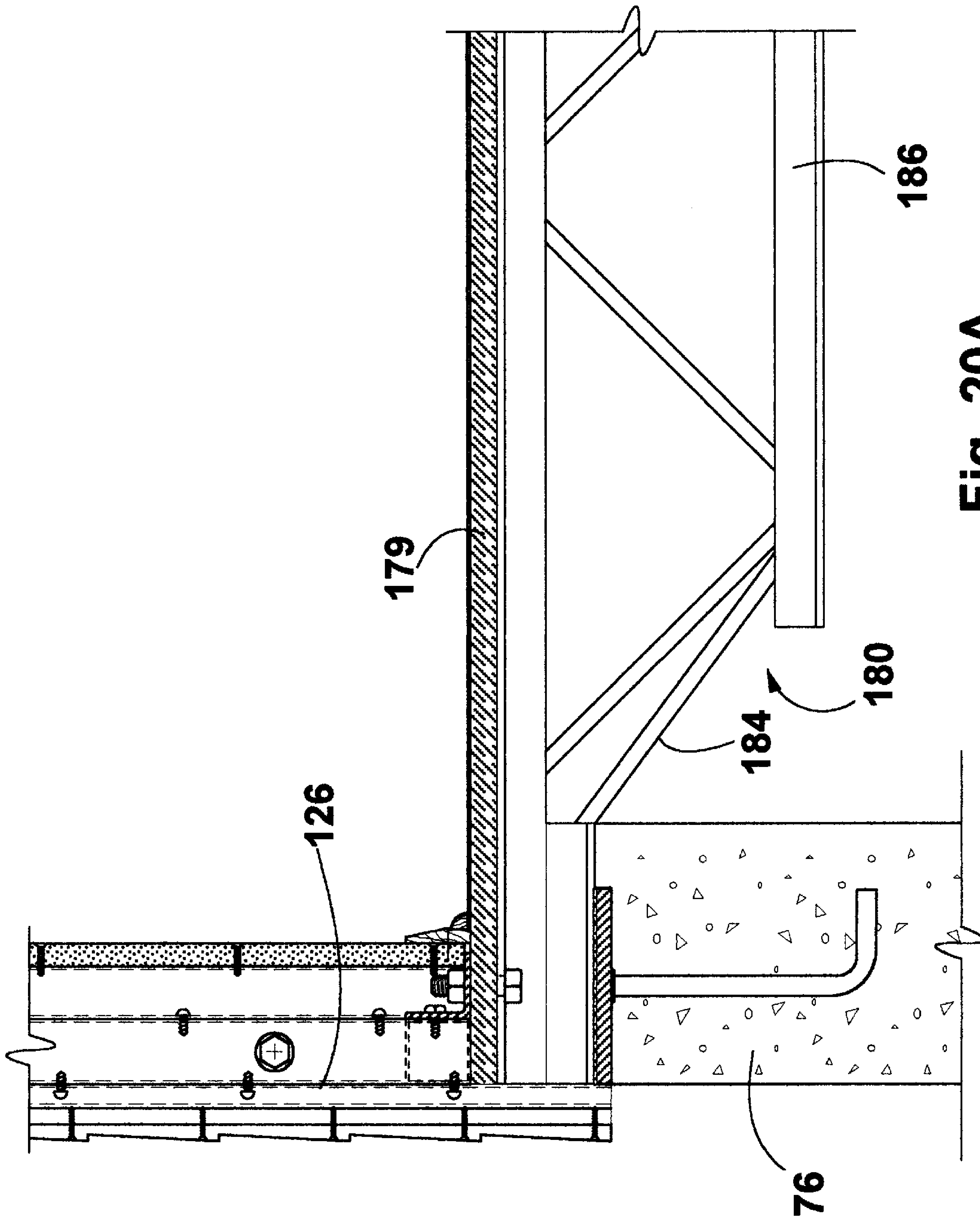

Fig. 20A

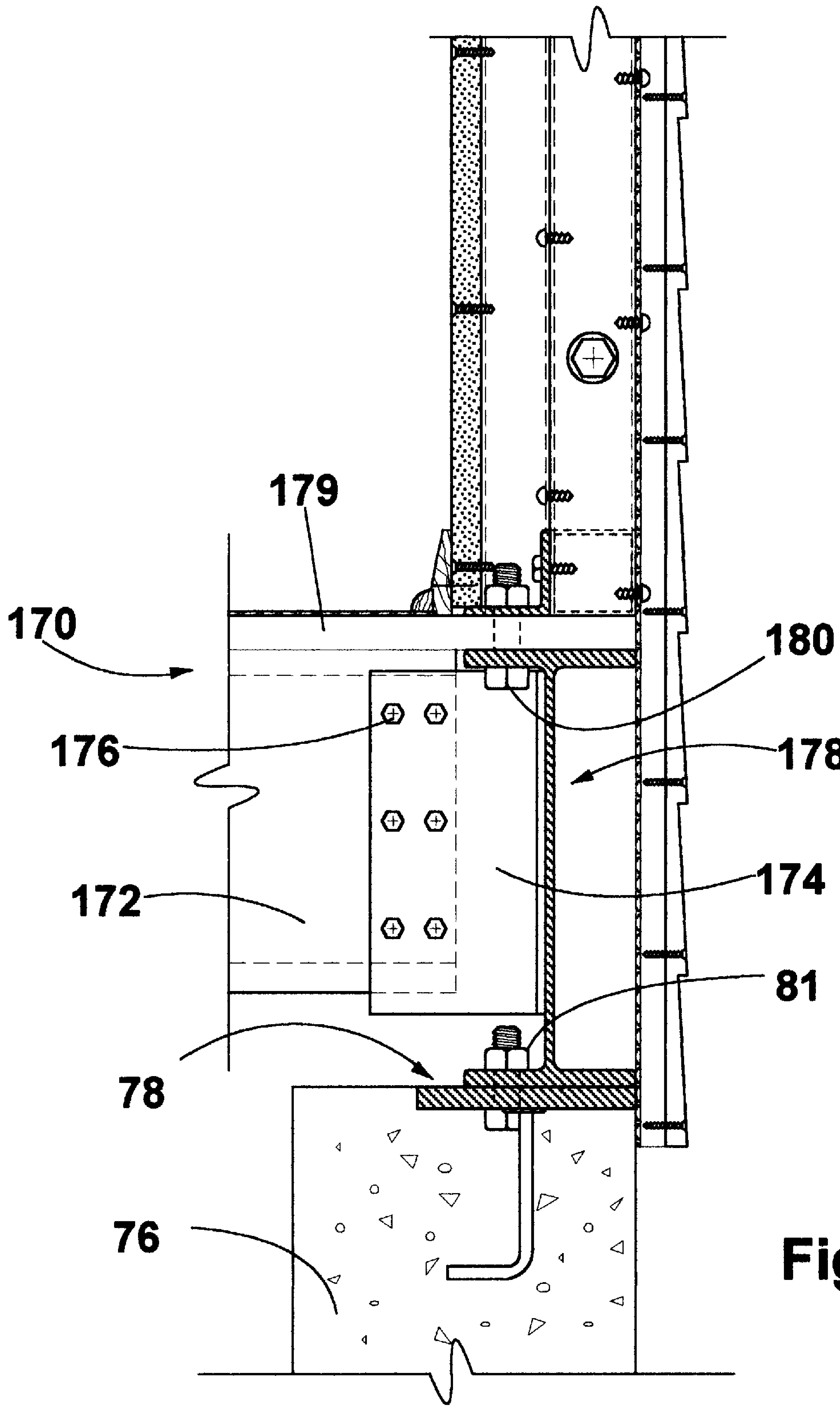

Fig. 21

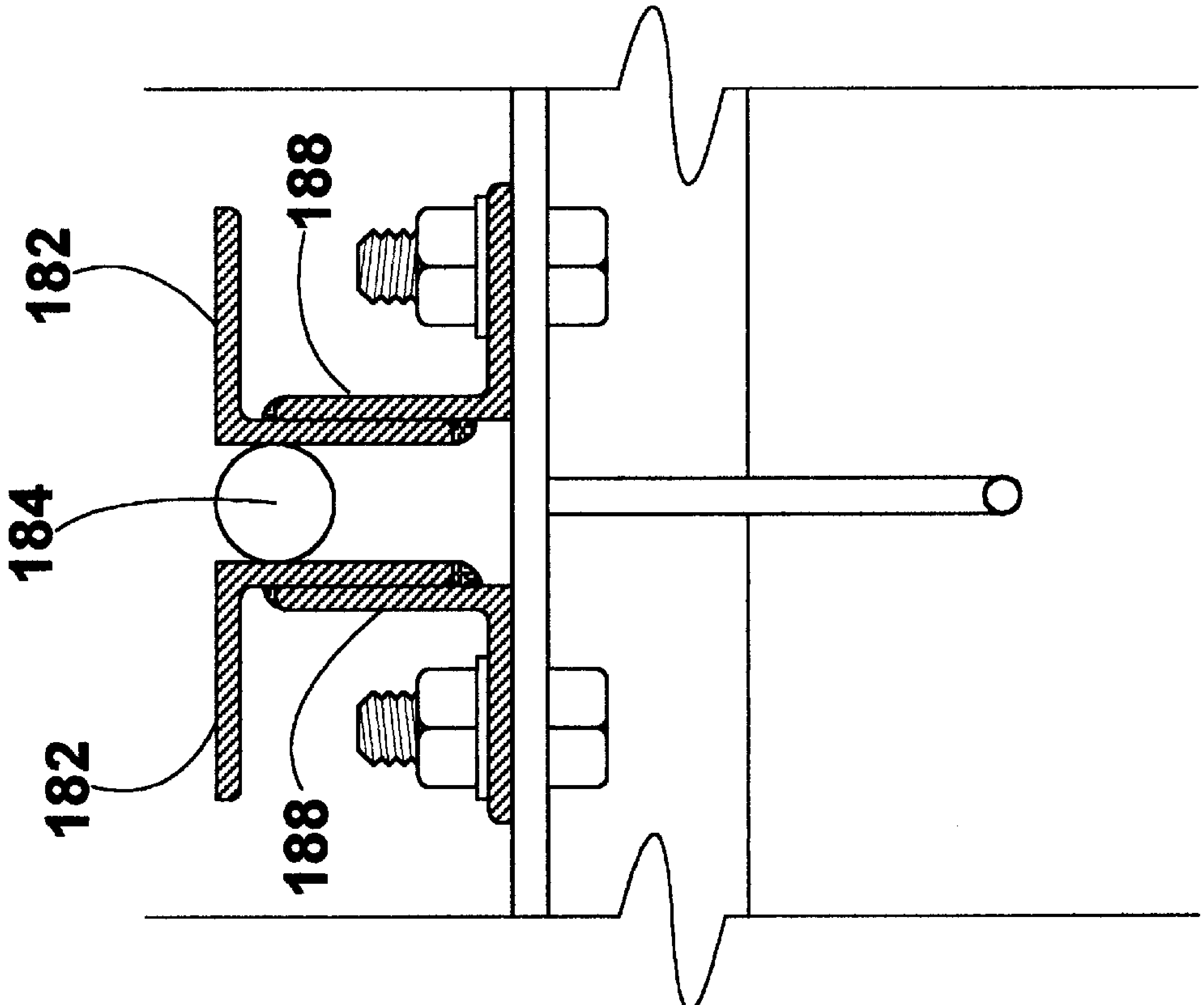

Fig. 23

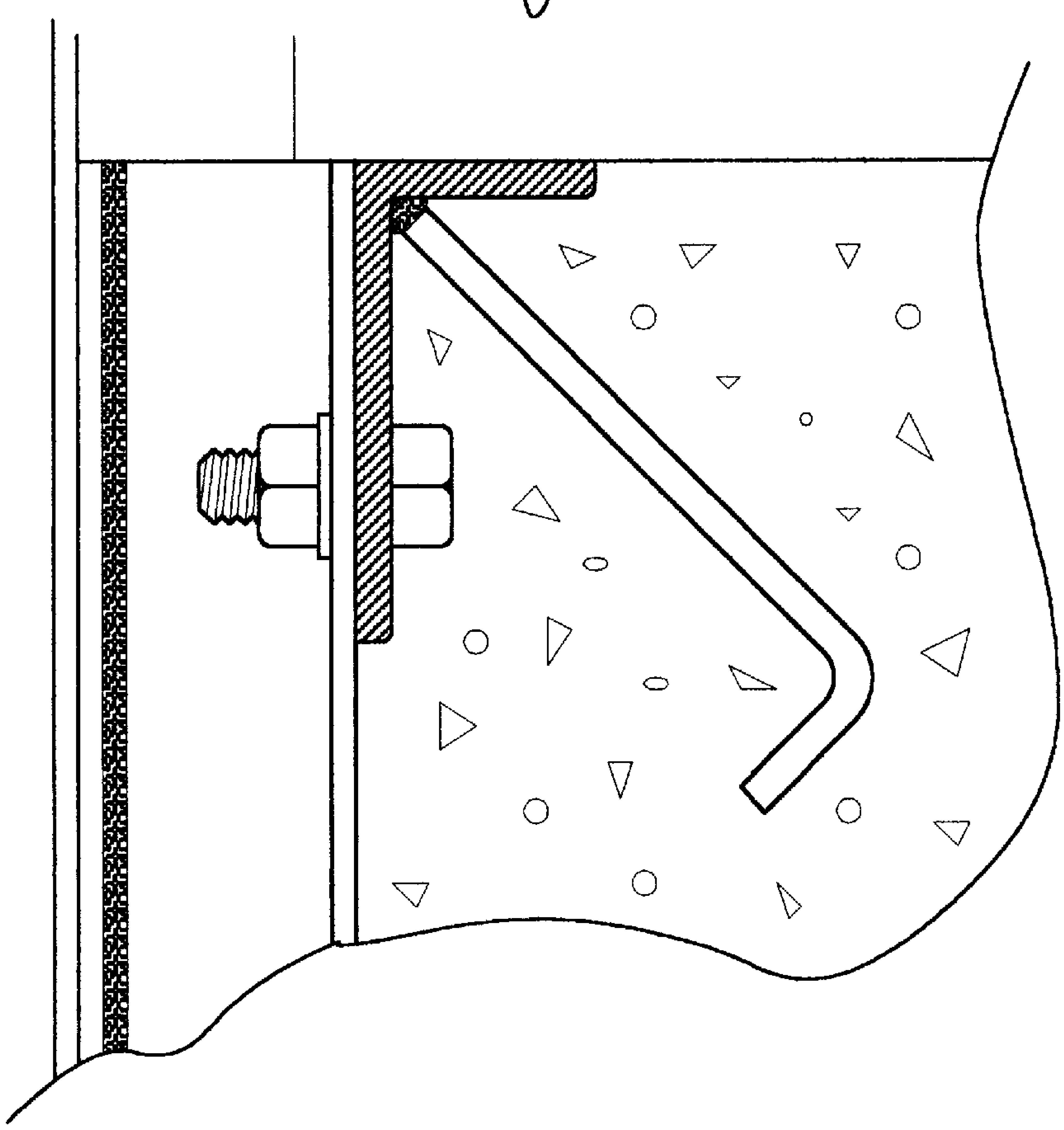

Fig. 22

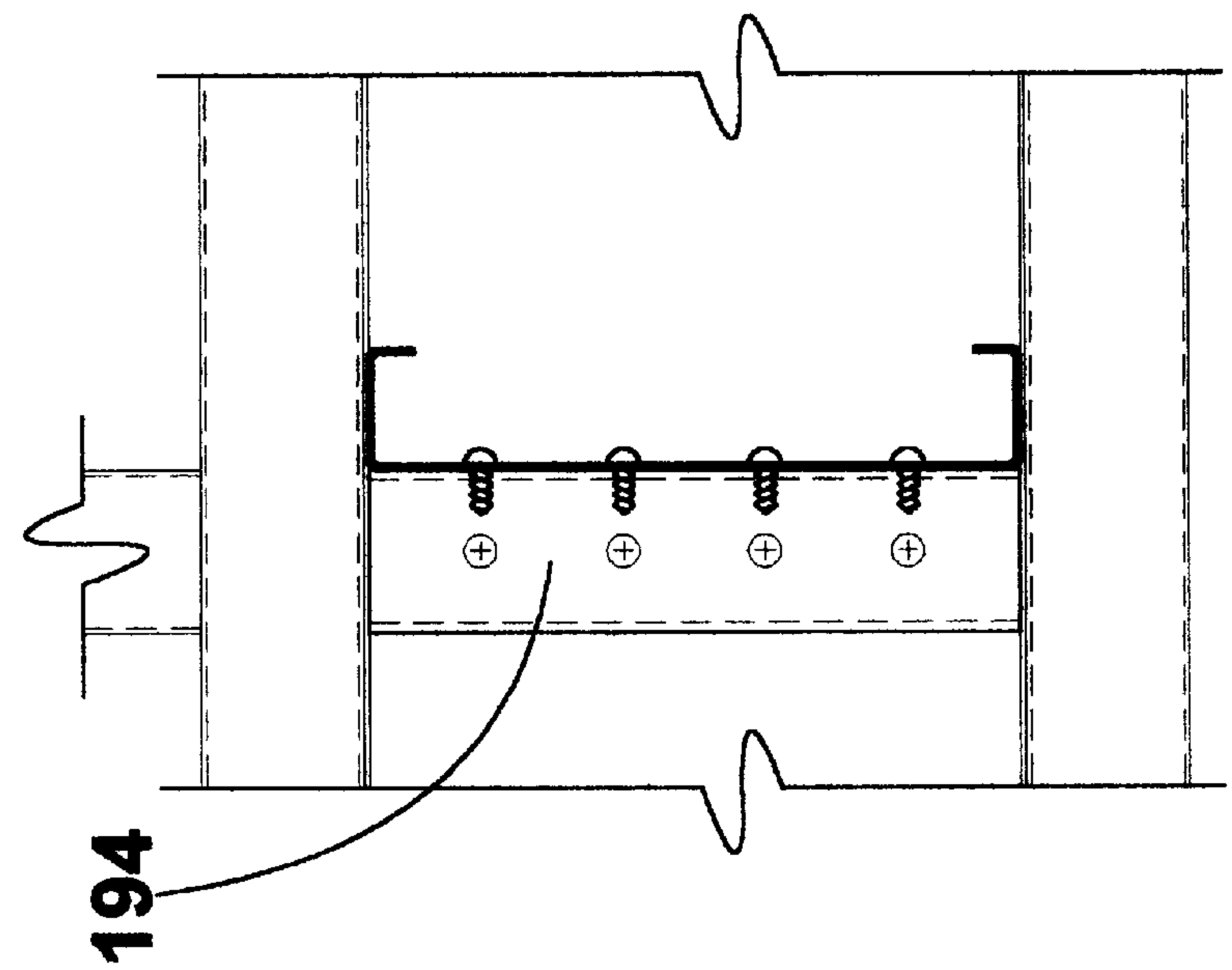

Fig. 25

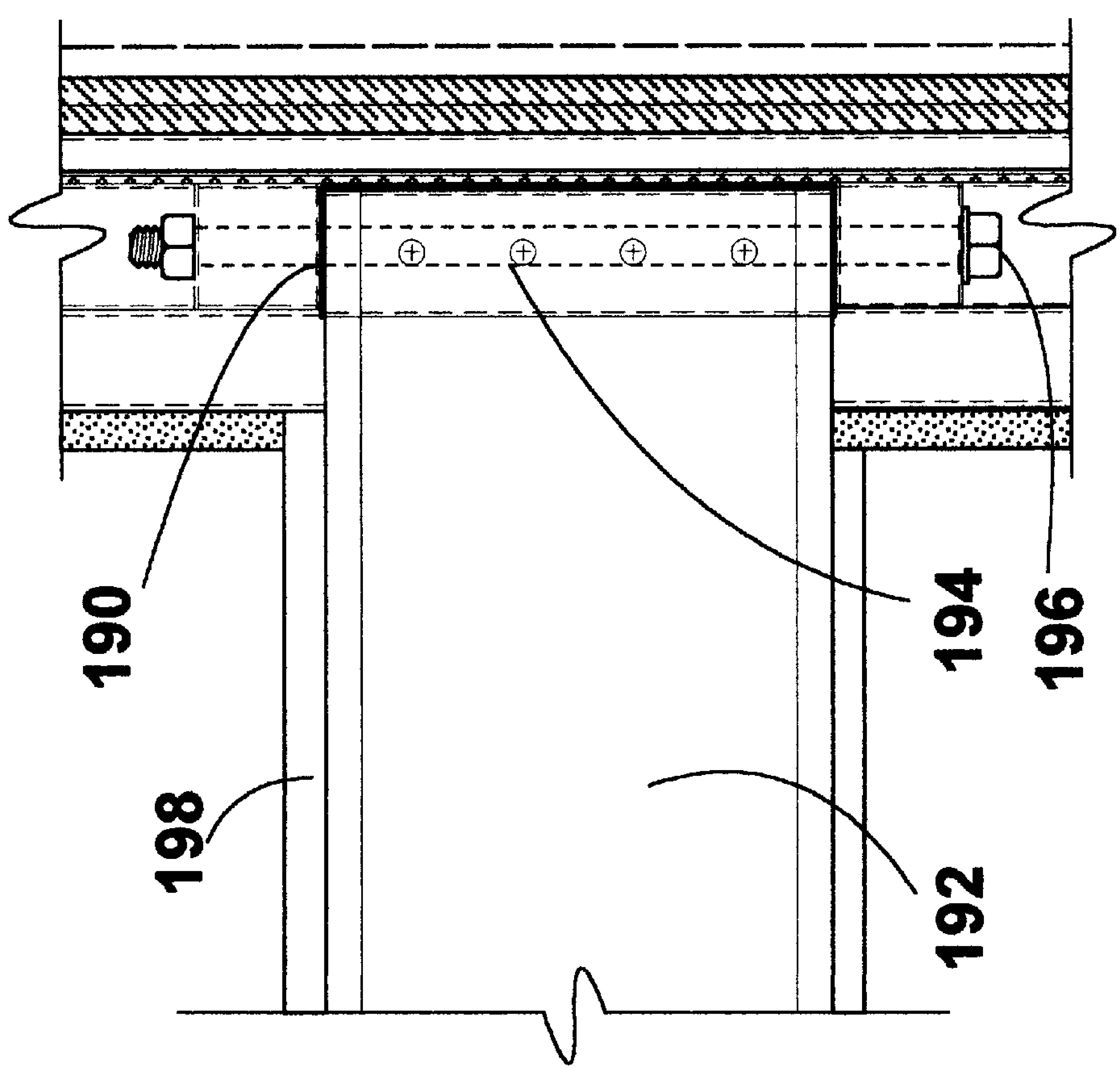

Fig. 24

MODULAR FRAME BUILDING

This is related to U.S. Provisional Application No. 60/001,777 filed on Aug. 2, 1995, and International Application No. PCT/US96/12,659 filed on Aug. 2, 1996, both entitled "Modular Frame Building".

This invention relates to modular frames for buildings and buildings constructed from such frames, and more particularly to high quality buildings that can be erected quickly and at low cost from tubular steel modular frame units that are fabricated off site and trucked to the building site where they are bolted together into a building frame by a small work crew without the use of heavy equipment.

BACKGROUND OF THE INVENTION

Conventional building practice for residence housing relies primarily on wood frame construction in which the building frame is constructed on site from framing lumber cut to fit piece-by-piece individually. It is a labor intensive process and demands considerable skill from the carpenters to produce a structure that has level floors, perfectly upright walls, square corners and parallel door and window openings. Even when the building frame is constructed with the requisite care and skill, it can become skewed by warping of the lumber, especially modern low grade lumber produced on tree farms with hybrid fast-growth trees.

Although conventional wood frame buildings require very little equipment for construction, they have become quite costly to build. The labor component of the cost is substantial, partly because of the straight wages that must be paid for the long laborious process of constructing the frame, and partly because of the many government mandated extra costs such as workman's compensation and liability insurance, social security payments, medical insurance premiums, and the host of reports that must be made to the Government by employers. Accordingly, employers now seek to minimize their work force by whatever means is available to minimize these burdensome costs.

Steel frame construction is commonly used on commercial buildings because of its greater strength, fire resistance and architectural design flexibility. The parts of the such a steel frame are typically built to order in accordance with the architect's plans, then trucked to the building site and assembled piece-by-piece with the use of a portable crane. The building can be made precisely and as strong as needed, but the cost is relatively high because of the skilled crew and expensive equipment need to assemble the building. It is a construction technique generally considered unsuitable for single family residence building because the cost is high and the building walls are substantially thicker than those made using standard frame construction, so standard door and window units do not fit properly and must be modified with special trim that rarely produces an aesthetic appearance.

Earthquake damage is becoming a matter of increasing concern among homeowners because of the publicity given to damage and loss of life in recent earthquakes in the U.S. and abroad. Earthquake preparedness stories and advice abound, but an underlying unresolved concern is that conventional wood frame homes in the past were not built to tolerate the effects of an earthquake, neither in its ultimate load-bearing capability nor its serviceability limits. Modern building codes attempt to address this concern, but the measures they require merely add to the already high cost of a new home and may not always provide significantly improved resistance to earthquake damage, particularly with respect to after-quake serviceability.

Fire often follows an earthquake, as happened in the disastrous Kobe earthquake of 1994, and of course fire is a major threat to homes independent of earthquake. When fire breaks out in a conventional home, the wood frame fuels the fire and reduces the chances of successfully extinguishing it before the entire structure is destroyed. The major life saving advance in the recent past is the fire alarm which detects the fire and merely alerts the occupants that a fire has started so they may escape before burning up with the house, but significant improvements to the fire resistance of the home itself that would retard the spread of the fire would be desirable.

The other major catastrophic threat to homes is wind. Wind loads on wood frame homes have destroyed many homes, primarily because the roof is usually attached so weakly to the walls that the combination of lift, exerted upward on the roof by the Bernoulli effect of the wind flowing over the roof, and pressure under the eves tending to lift the roof off the walls, wrenches the roof off the walls and allows the wind to carry the roof away like a big umbrella.

Termite and carpenter ant damage to wood frame homes is a major form of damage, costing many millions of dollars per year. Although the damage done by insects is rarely life threatening, it is actually more extensive in total than the combined effects of wind and earthquake, and it is an ever present danger in many parts of the country.

Thus, there exists an increasing need for a home building frame design that would enable the inexpensive construction of homes that are highly tolerant of the effects of earthquakes, do not support combustion, are capable of withstanding high winds, are immune to damage from insects, and can use standard building components such as door and window units. Such a building frame concept would be even more commercially valuable if it were possible to erect the building in a short time with a small crew and without heavy equipment, and the frame could be adapted to produce buildings of attractive building styles desired locally.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide an improved building frame that can be assembled rapidly at the building site by bolting together metal frame modules fabricated off site. Another object of this invention is to provide an improved metal frame for a house that can be made to withstand severe earthquakes and high winds yet be much less costly than comparable wood frame houses. Yet another object of this invention is to provide an improved process for constructing a frame for a house that is less costly than conventional wood frame houses and substantially more resistant to damage from earthquakes and wind. A further object of this invention is to provide an improved steel frame home building having walls the same thickness as conventional wood frame homes so that standard door and window units can be used with normal appearance, but the building has the strength and fire resistant benefits of a steel frame building while costing less than conventional wood frame buildings.

These and other objects of the invention are attained in a building frame for a building able to withstand severe earthquakes and gale-force wind loads, including side walls made of side wall frame modules bolted together along adjacent edges and end walls made of end wall frame modules bolted together along adjacent edges. The frame modules are constructed of rectangular steel tubing, typically 2"×2", welded together in a welding jig to ensure exact 90° angles. At least some of the side and end wall frame modules have diagonal bracing to provide rigidity against wind loads and folding forces experienced during earthquakes. The end walls are each bolted at their ends to ends of the side walls to form a peripheral wall of the building. Trusses for supporting a roof on the peripheral wall are bolted into pockets on top of the side walls between structural members at the top of the wall to secure the roof of the building on the peripheral wall. The peripheral wall is secured to a concrete foundation by attachment of the frame modules to anchors set in a concrete foundation. The anchors have attachments for establishing a high strength tensile load path between the foundation and the frame modules. Metal studs are fastened on the inside surfaces of the wall frame modules extending vertically for attachment of interior wall board. Vertically extending stringers are attached to the outside surfaces of the wall frame modules for attachment of external siding. The roof is attached to the trusses by the use of longitudinally extending perlins attached to brackets that are pre-welded to the top of the trusses. The perlins extend over the trusses for attachment of roof sheathing. A high strength tensile load path is thus established through steel structure from the foundation through the frame to the roof for resisting high wing loading and shaking forces of earthquakes.

DESCRIPTION OF THE DRAWINGS

The invention and its many attendant objects and advantages will become better understood upon reading the following description of the preferred embodiment in conjunction with the following drawings, wherein:

FIG. **1** is a perspective view of a building frame made in accordance with this invention;

FIG. **1**A is a detail of one corner of the building frame shown in FIG. **1**, showing the struts exploded out of the truss pocket at the top of the building wall frame;

FIG. **2** is a cross sectional elevation of the eve region of a building constructed in accordance with this invention, showing a roof supported on longitudinally extending purlins attached to trusses supported on a peripheral frame wall of the building;

FIGS. **3**A–**3**K are perspective and elevational views of various representative building frame wall modules for use in buildings made in accordance with this invention;

FIG. **4** is a perspective view of a corner of a building frame made in accordance with this invention with some of the wall frame modules used in the building frame shown in FIG. **1**, but without the double trusses and internal wall frames shown therein;

FIG. **4**A is a sectional elevation showing the attachment of a truss in a pocket between the upright stub members atop two adjacent wall modules;

FIG. **4**B is a sectional elevation through a truss where it sits on the peripheral wall, showing a modified truss attachment structure;

FIG. **5** is plan view of a portion of a peripheral wall at the junction between two adjacent wall modules, showing a connection to one embodiment of a foundation anchor;

FIG. **6** is a sectional elevation along of the structure shown in FIG. **5** showing a corner foundation anchor attached to two adjacent frame modules;

FIG. **7** is a sectional plan view of a corner section of the building frame shown in FIG. **1**, showing the attachment to a corner foundation anchor;

FIG. **8** is a sectional elevation of the wall of a house built in accordance with this invention showing the building frame attached to an alternate embodiment of a foundation anchor;

FIGS. **9**A and **9**B are sectional plan views of the structure shown in FIG. **8**, showing Z-shaped and channel (C) shaped studs, respectively;

FIG. **10** is a perspective view of a truss for supporting a roof in buildings made in accordance with this invention;

FIG. **11** is an elevation of the center of an end truss at its connection with a supporting end wall frame;

FIG. **12** is a schematic perspective view of a building frame made in accordance with this invention with diagonal bracing between the trusses in both horizontal and vertical planes;

FIG. **13** is a schematic plan view of a building made in accordance with this invention with cross bracing between the lower chords of the trusses, as indicated in FIG. **12**;

FIG. **14** is a plan view of a connection for cross bracing at the ends of the trusses;

FIG. **15** is a plan view of a connection for cross bracing at the center of the trusses;

FIG. **16** is a schematic elevation of a building frame according to this invention, showing diagonal bracing in the vertical plane for the trusses;

FIG. **17** is a perspective view of an upper chord of a truss shown supporting a purlin, and showing a connector clip for attaching the purlin to the truss;

FIGS. **18** and **19** are sectional plan views showing the connection of conventional door and window units in a building frame of this invention;

FIG. **20** is a broken sectional elevation end view of a building in accordance with this invention showing the building frame supported on floor joist over a foundation;

FIG. **20**A is a sectional elevation end view of a building in accordance with this invention showing the building frame supported on different type of floor joist over a foundation;

FIG. **21** is an enlarged view of the other end of the joist shown in FIG. **20** supported on the foundation and supporting the building frame;

FIGS. **22** and **23** are enlarged sectional side and end views of the end portion of the joist shown in FIG. **20**A and its attachment to the foundation;

FIGS. **24** and **25** are sectional side elevation, and end elevation views of a junction between a first story and a second story of a building in accordance with this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to the drawings, wherein like reference numerals designate identical or corresponding parts, and more particularly to FIG. **1** thereof, a building frame is shown having a peripheral wall **20** made of two end walls **22** and **24** connected at their ends to ends of two side walls **26** and **28**. The side walls **26** and **28** support opposite ends of a plurality of trusses **30** spaced apart along the side walls at regular intervals, and each end wall **22** and **24** supports an end truss **30'**. The trusses **30** are supported in pockets **48** atop the side walls **26** and **28** and extend beyond the outside surfaces of the side walls **26** and **28** to provide an overhanging eve. A plurality of longitudinally extending purlins **32** are attached to the trusses **30** for supporting a roof **34**, shown in FIG. **2**.

The wall modules **36** for the end walls **22** and **24** and the side walls **26** and **28** are fabricated off site and trucked to the building site where they are bolted together into a building frame. The modules are made in a welding shop out of lengths of metal tubing, welded together at precisely 90° so that the assembled building frame is perfectly true and square when bolted together. The tubing is preferably commercially available 2"×2" galvanized square steel tubing having a wall thickness of 0.083", ASTM-A-500 with a yield strength of about 50 KSI and a tensile strength of about 55 KSI. Naturally, other material could be used, but this material is preferred because it is widely available from many sources at low cost and in various wall thicknesses for different strength requirements. The modules are preferably welded together on a welding jig that holds the lengths of tubing at the desired 90° within about 2°, or preferrably within about 1° tolerance. Care should be taken to avoid heat distortion of the assembly during welding, for example by tack welding the entire module together before completely welding the junctions. MIG welding has been found to produce clean welds that do not require de-slagging and also minimize heat input into the junction. If enough welding jigs are not available for the desired production rate, the first module may be made on the welding jig and the other identical modules may be made on top of the first as a pattern.

The preferred side wall modules **36**, shown in FIGS. **3**A–3E, are about eight feet square, although the dimensions can conveniently be varied for different house designs and ceiling heights if desired. The modules are preferably dimensioned to use standard interior wall board, such as that commonly sold in 4'×8' panels, so the wall may be built without extensive cutting of the wall board.

The side wall module **36**A shown in FIG. **3**A includes two upright end members **40** and five longitudinal or girt members **42** welded between the end members **40**. The upper and lower girt members **42*u*** and **42*b*** are welded flush with the top and bottom of the end members **40** and extend at 90° thereto, and the three intermediate girt members **42*i*** are spaced equally between the members **42*u*** and **42*b*** and parallel thereto. Some of the corresponding side wall modules shown in FIG. **12** use only one intermediate girt member **42*i***, which produces a wall module that is strong enough for buildings subjected to normal stresses. The extra intermediate girt member **42*i*** in FIG. **3**A illustrate the ease with which the frames for buildings can be designed and built for various load conditions.

Two upstanding stub members **44**, made of 4" lengths of the same 2"×2" steel tubing, are welded to the upper girt member **42*u*** of the side wall modules **36**, and an eve strut **46** is welded between them about 2" above and parallel to the upper girt member **42*u*** and flush with the top of the stub members. The stub members are each off-set from the outer edge of the end members **40** by about 1", leaving a pocket **48** about 2" wide directly over two abutting upright end members **40**, shown in FIG. **4**A, between adjacent stub members **44** on adjacent side wall modules **36**A for receiving end portions of the trusses **30** and directly supporting the trusses **30** on the abutting upright end members **40**, as will be described in more detail below. The eve strut **46** stiffens the connection of the trusses **30** to the wall modules **36** in the pocket **48** and allows the stresses exerted by the trusses on the stub members **44** to flow through the modules **36** from one side to the other. The pockets **48** in the side walls **26** and **28** are each defined by a floor **45** and opposed side surfaces **47** extending completely through the side wall from the inside face to the outside face. The floor **45** of each pocket **48** lies flush with (in fact is defined by) the top surface of the upper frame member **42*u***, which lies below the top-most surface of the side walls **26** and **28**, namely, the top surface of the eve strut **46**.

The building frame shown in FIGS. **1** and **1**A is specially designed to be disassembled and moved in 10' wide sections. It has double trusses **30** and double interior wall frames extending parallel to the end wall frames **22** and **24**. The truss pocket into which the trusses fit is twice the normal width, i.e. 4" instead of the normal 2", because the pocket holds two trusses **30** instead of just one truss. At the building site, the five sections shown can be moved into abutting position side-by-side and bolted together to complete the building frame. This is not the way a building in accordance with this invention would normally be built (described below) and is more expensive because of the extra frame modules and trusses **30**, but it illustrates the versatility that the inventive building system provides.

The pocket **48** shown in FIG. **2** is deeper by 2" than the pocket shown in FIG. **4**A, achieved by using stub members **44**' that are 6" long instead of 4". The longer stubs **44**' raise the eve strut **46** to about the height of the upper chord of the truss **30**, providing an attachment at the level of the roof sheath for the vertically extending stringers to which the exterior siding is attached. The depth of the pocket **48**, or the height of the eve strut **46** above the upper girt member **42*u***, is easily designed to reach the underside of the roof sheath, which varies in height above the upper girt member **42*u*** depending on the slope of the truss. The depth of the pocket is set by the length of the stub members **44** and whether the eve strut **46** is welded atop the stub members **44** or welded to the side of the stubs **44** flush with their top ends.

The wall modules for the end wall **22** end are identical to the side wall modules **36** except that the stub members **44** and the eve strut **46** are not used, as shown in FIGS. **3**F, **3**G and **3**K and also in FIGS. **1**A and **4**, so the upper girt member **42*u*** is the topmost structural member on the end wall modules. This enables the lower chord of the end trusses to lie directly atop and be fastened to the upper girt members **42*u*** of the end walls **22**, as shown in FIGS. **1** and **11** and discussed below.

A door wall module **36**B shown in FIG. **3**B includes the same upright end members **40** as the wall module **36**A, but it has two upright door opening members **50** and **52** welded to the upper longitudinal member **42*u***. The other longitudinal members **42** are welded between the end members **40** and the adjacent door opening member **50** or **52**, and a longitudinal door opening member **54** is welded between the upright door opening members **50** and **52** at about the seven foot level as the upper limit of the door opening in the module **36*b***. An eve strut **46** is welded between two upstanding stub members **44** on the top of the upper longitudinal member **42*u***. Three other door opening modules are shown in FIGS. **3**F, **3**G and **3**H. These modules provide upright supports **50** only on one side and are designed to be attached by way of two bolts through an upright stub **51** to an adjacent wall module whose adjacent upright end member **40** provides the other side of the door opening and supports the cantilevered header over the door opening.

Window wall modules **36**C and **36**J, shown in FIGS. **3**C and **3**J, include the same upright end members **40** as the wall modules **36**A and **36**B. Module **36**C has a window opening centered in the module between two upright window opening members **56** and **58** welded between the upper girt member **42*u*** and the bottom girt longitudinal member **42*b***. The other intermediate members **42*i*** are welded between the upright end members **40** and the two upright window opening members **56** and **58**. Top and bottom longitudinal window opening members **60** and **62** are also welded between the two upright window opening members **56** and **58** to outline the window opening. An eve strut **46** is welded between two upstanding stub members **44** on the top of the upper girt member **42***u* on the window wall module **36**C. The window opening module **36**J has the window opening one one side of the module and has only one upright window opening member **56**, using the upright end member **40** as the other upright window opening member.

As shown in FIG. **1**A, a diaphragm shear module **36**D, shown in detail in FIG. **3**D, is added into the peripheral wall **20**, preferably on all four sides when extreme diaphragm stiffness is desired, to provide strength and stiffness in the plane of the wall section for resistance against deflection toward a parallelogram shape under wind loads or lateral shaking during an earthquake. Because of the low height-to-width ratio of one and two story buildings that will normally use this invention, shear distortion will predominate over flexural distortion due to bending as a cantilever, so shear bracing is added for resistance to this mode of deflection to minimize not only threats to the safety of the occupants but also to the serviceability of the building after the windstorm or earthquake.

The module **36**D includes the same upright end members **40** as the wall modules **36**A–**36**C and a center intermediate girt member **42***i*, but has two upper diagonal brace members **64** and **66** welded between the upper corners of the module and the center of the center intermediate girt member **42***i*. A pair of lower diagonal brace members **68** and **70** are likewise welded between the lower corners of the module **36**D and the center of the center intermediate girt member **42***i*. The module **36**D is about the same weight as the module **36**A but is much stiffer for resisting a lateral force couple in its plane. When bolted into a wall section, the combination of the module **36**D with the other modules contributes salutary stiffness to the entire wall section. Deflections in the wall of a building with such high shear strength wall due to lateral wind loads and shaking due to earthquake will be minimal, thereby greatly reducing the structural damage cause to the building by such events.

A second diaphragm shear module **36**E, shown in FIG. **3**E and shown in FIG. **3**K as an end wall module without the eve strut **46**, includes the same upright end members **40** as the wall modules **36**A **36**D and a center intermediate girt member **42***i* like the module **36**D, but has only two diagonal brace members, an upper one **72** and a lower one **74**. The upper diagonal brace member **72** is welded between an upper corner of the module **36**E and a junction between the center intermediate girt member **42***i* and the upright end member **40** on the opposite side from the upper corner. The lower diagonal brace member **74** is welded between the lower corner of the module **36**E, on the same side as the upper corner to which the upper diagonal brace **72** is welded, and the underside of the same junction between the center intermediate girt member **42***i* and the upright end member **40** to which the upper diagonal brace **72** is welded. This second diaphragm shear module **36**E is lighter and uses less material and fewer welds that the module **36**D, but is a bit less strong. The diaphragm shear modules **36**D and **36**E may be used in combination or separately, depending on the size and desired resistance to wind loads and earthquake effects as specified by the customer.

A header module **36**I designed primarily to span openings in the side wall **26** for sliding doors or the like, has two girt members **42***u* and **42***b* separated by two short upright end members **40**'. The header **36**I shown in FIG. **3**I also has an eve strut attached to two inset stub members **44** like the other side wall modules.

The wall modules **36** for the house are fabricated in a welding shop and the weld junctions are painted with a galvanizing paint in preparation for transportation to the building site. At the building site, a concrete foundation **76** is poured and anchors **78** are embedded in the concrete before it cures so that, on curing, the side anchors **78** are permanently fixed in the foundation. The foundation could be a perimeter footing around a slab, or it could be a basement perimeter wall as shown in FIGS. **20**, **20**A, and **21**, depending on the house design. It could also be piers, pillars or grade beams or numerous other known foundation designs. The embedded anchors **78**, one of which is shown in FIGS. **5** and **6**, each include a J-bolt **80** and a top plate **82** welded to the top of the J-bolt **80**. The top plate **82** has a central hole about the same diameter as the J-bolt diameter and receives the J-bolt into the hole for welding to the top and bottom of the plate **82**. Alternatively, the J-bolt could be welded directly to the underside of the plate **82**. A right angle bracket **84** is welded to the top plate **82** for attachment of the lower longitudinal members **42***b* or the bottom ends of the upright end members **40** of the frame modules **36** where they are connected to each other, as shown in FIG. **5**. The bracket **84** is wide enough to span the entire width of the abutting upright end members **40** as shown in FIG. **5**.

The anchors **78** are placed in the foundation **76** at positions corresponding to the junctions between adjacent wall modules **36** and the brackets **84** welded to the plate **82** at a position spaced back from the foundation edge a distance equal to the width of the module tubing, or 2" from the outer edge of the top plate **82** so that the outside surface of the lower longitudinal members **42***b* lies flush with the outer edge of the foundation to facilitate the attachment of insulation and exterior siding overlapping the frame and foundation without an unsightly or condensation-collecting step at the interface of the frame and the foundation.

A corner anchor **78**', shown in FIG. **7**, is placed at each corner of the foundation **76** in line with the side anchors **78**. The corner anchor **78**' is identical to the side anchors **78** with the single exception that the bracket **85** for connecting the anchor to the frame modules **36** at the corner of the peripheral wall **20** has two upstanding flanges **87** lying at right angles to each other and welded together along their adjacent edges. The two upstanding flanges **87** are fastened to the wall modules **36** at the corner after the wall modules are connected together, as explained below. Alternatively, the corner anchor **78**' may be attached to the foundation using a threaded rod **79** that is set into a hole H drilled into the foundation and secured therein with epoxy. A nut **83** is tightened onto the threaded rod **79** after the epoxy has set to hold the anchor plate **82** down against the top of the foundation. This type of threaded rod **79** can also be used on the side anchors, as shown in FIGS. **8**, **9**A and **9**B, embedded in the foundation **76**, but has a free upper end **81** that is threaded for threadedly receiving the nut **83**. A bracket **84**' has a central hole that fits over the threaded end **81** of the J-bolt **79** and is held down against the top surface of the foundation **76** by the nut **83**. The bottom longitudinal members **42***b* or lower end of the upright end members **40** are fastened to the bracket **84**' by screws **77** in the same manner as for the anchor shown in FIGS. **5**–**7**.

The trusses **30** shown in FIGS. **1**, **1**A, **2** and **10**, are constructed of an upper chord **88** made of two pitched tubular steel members, described above, lying at an angle of 20° or more to a lower chord **90** to which they are welded.

A plurality of internal brace members **92** are welded between the upper chord **88** and the lower chord **90**. The trusses may be Pratt trusses in which half of the internal members **92***v* between the upper and lower chords are vertical and in compression, and the other half **92***s* are sloping and in tension. The connection between the upper chord **88** and the lower chord **90** in each truss **30** includes a connector plate **94** welded to both sides of the truss **30**. The connector plate may be sized for the size of the truss, but is typically about 4"×8" and about ⅛" thick. The width of the pocket **48** between the upright stub members **44** is made wide enough to accommodate the connector plates **94** on each side of the truss, as shown in FIG. **4**A. An apex connector plate **96** is welded on each side of the truss at the apex of the two pitched halves **88** where they are welded together and to the center vertical internal member **92***c*.

After the wall modules **36** and trusses **30** have been fabricated in the shop and the foundation has cured with the anchors **78** and **78**' in place, the wall modules and trusses are trucked to the building site and unloaded around the foundation at about the positions they will occupy on the foundation. The modules **36** can be tipped up with a small crew and bolted together with bolts **106** extending through aligned holes in the upright end members **40** at the top and bottom adjacent the upper and lower longitudinal members **42***u* and **42***b*, with an additional bolt **106** at about the mid-level height of the end members **40**. Advantageously, the corner modules are fastened together first, and then the intermediate modules are then added and secured with bolts **106**. When all the wall modules have been erected and connected together, the bolts **106** are tightened, starting with one of the corners fastened with the right angle flange **86** shown in FIG. **7** and working around the peripheral wall **20** in both directions toward the opposite corner. The holes for the bolts in the upright end members **40** of the wall modules **36** are preferably predrilled in the shop but may also be drilled at the building site by aligning and clamping the frame modules **36** together and then drilling the bolt holes through the clamped upright end members **40** of the adjacent modules **36**. Finally, the moduless are all fastened to the anchorflanges **84** and **87**, as shown in FIGS. **5**–**7**.

When all the wall modules have been bolted together to complete the peripheral wall **20**, the trusses **30** are lifted onto the top of the peripheral wall **20** for attachment thereto. The end trusses are attached first by laying the bottom chord **90** atop the upper longitudinal member **42***u* of the end walls **22** and **24** and fastening the depending portion of a connector plate **103** welded to the center and several other spaced locations on the lower chord **90** to the upper longitudinal member **42***u*. The other trusses between the end trusses are fitted into the pockets **48** between the upstanding stub members between adjacent side wall modules **36** where they are supported without bracing until they are bolted into place.

A hole is drilled in the shop through the upstanding stub members **44** and preferably also through the lower chord **90** of the trusses **30**, and a bolt **107** is inserted through the holes to secure the trusses to the peripheral wall **20**. Alternatively, the upright stub members **44** could be predrilled and the truss lower chord **90** back drilled when it is in place to avoid the possibility of slight misalignment of the holes when the parts come together. The bolting of the trusses into the pockets **48** through the upright stub members **44** secures the roof to the peripheral wall **20** and, together with the anchoring of the peripheral wall **20** to the foundation, anchors the roof to the foundation against displacement due to wind loads or differential movement of the foundation and the building during an earthquake. The bolt **107** is tightened to exert a strong frictional force between the stub members **44** and the truss so the hold-down force on the roof does not depend on the shear resistance of the bolt **107**.

The end trusses have no pockets to fit into, but they do fit into notches created by the offset of the upright stub members **44** on the side wall modules **36** to which they are bolted. To provide additional strength and rigidity of the connection of the end trusses to the end walls **22** and **24**, connector plates **103**, shown in FIG. **11**, are welded to the lower chord **90** of the truss at its center point and at the two or more positions along the length of the lower chord **90**, and at its ends. The connector plates **103** each have a portion depending downward from the truss and lying alongside the upper girt member **42***u* of the modules on the end walls **22** and **24**. The depending portion of the connector plates **103** are fastened by self-drilling, self-tapping screws or the like to the outside surface of the modules in the end walls **22** and **24** to provide resistance to overturning forces while the trusses are being erected.

As shown in FIGS. **12**–**15**, diagonal bracing may be provided in the horizontal plane at the top of the wall modules between the trusses for increased stiffness against wind loads. As shown most clearly in FIG. **13**, cross braces **108** are connected from the junctions of the trusses **30** and side walls **26** and **28** to the center of the adjacent trusses. The connection of the diagonal braces **108** to the ends of the trusses **30**, shown in FIG. **14**, includes a connector plate **110** welded to the underside of the lower chord **90** of the trusses **30** adjacent to their connection the side walls **26** and **28**. An L-shaped bracket **112** is welded to each end of the cross braces **108** and is attached to the connector plate **110** by bolts **114**. The other ends of the diagonal braces **108** are attached to center connector plates **115** welded to the underside of the lower chords **90** of the trusses **30** at the midpoint of their length. The diagonal braces are attached by means of bolts **114** to brackets **112** welded to the ends of the braces **108**. A stiffening gusset **116** may be welded between the connector plate **115** and the center vertical brace **92***c*.

Diagonal cross bracing in a vertical plane for the trusses **30** may be provided as shown in FIGS. **12** and **16** to give lateral support for the trusses against racking wind loads. The bracing includes braces **118** connected between the apex of the upper chord **88** on each truss **30** to the center of the lower chord **90** on each adjacent truss. The braces **118** are connected at each end to connector plates by bolts, and are bolted together where they cross each other at **120** to improve resistance against the tendency to buckle under compressive load.

After all the trusses **30** have been lifted into place and bolted into the pockets **48**, the longitudinally extending purlins **32** are fastened to brackets **122** prewelded onto the upper chord **94** of the trusses, as shown in FIG. **17**. The purlins **32** lie atop the trusses **30** and connect them together. Roof sheathing **124** is laid over and screwed to the purlins, as shown in FIG. **2**, and the roof is sealed and shingled in the usual manner.

As shown in FIGS. **2**, **8**, **18** and **19**, a vapor barrier and insulating material **126**, such as the material sold commercially as Astrofoil, is taped around its edges to the wall modules **36** and is clamped in place by a series of vertically extending hat channels **130** which are attached by self-drilling screws **128** or the like to the exterior surface of the peripheral wall **20** over the insulation **126** to the outside surface of the peripheral wall **20** for attachment of exterior siding **132**.

Vertically extending metal studs **140** are fastened to the wall modules **36** at regular spacing therealong, e.g. every 2 feet. The studs are fastened by self-drilling screws **142** or the like, and provide an inside surface on a plane to which interior wallboard **144** can be connected by self-drilling wallboard screws **146**. Before fastening the wallboard **144**, fiberglass insulation or rigid board insulation is installed in the space between the inside surface of the insulation material **126** and the plane defined by the inside surface of the metal studs **140** to which the wall board **144** is attached. The attachment of the metal studs **140** stiffens the wall modules **36** and also provides damping by the friction between the studs **140** and the modules **36** in the event of an earthquake to dampen the oscillation of the stiff metal frame structure provided by the bolted unitary peripheral wall and truss structure. Two different types of studs **140** are shown in FIGS. **9**A and **9**B. In FIG. **9**A, Z-studs are shown which are very easy to attach to the frame modules **36** because of the off-set flange. In FIG. **9**B, C-studs are shown which are actually preferred because they are stiffer and less expensive.

As shown in FIGS. **2** and **10**, ceiling wallboard **150** is attached to hat-channels **152** connected to the underside of the lower chord **90** of the trusses **30** and to a series of C-channels **154** hung by wire **155** from the purlins **32** at the same level as the lower chords **90** of the trusses **30**, as shown in FIG. **10**.

FIGS. **18** and **19** illustrate how conventional window units **158** and door units **160** fit into walls constructed in accordance with this invention. The proportions of the dimensions of these units to the overall thickness of the wall is the same as it is for conventional wood frame construction, so the appearance of houses built with metal frame modules as described is the same as conventional houses. The standard prefabricated window and door units attach directly into the window and door openings exactly, without shimming, because the openings are fabricated with exact 90° inside corners and are accurately sized to receive the window and door units with a snug sliding fit. The units are attached with self-drilling, self-tapping screws **162** and **164** directly into the window and door opening members, and suitable trim is applied as shown to complete the installation.

When the floor of the building does not sit on a slab, or when there is more that one story, it is necessary to support one or more floors on floor joists. Two different types of floor joists are shown in FIGS. **20–23**, and a second story floor joist treatment is shown in FIGS. **24** and **25**. A C-chanel joist is shown in FIGS. **20** and **21**, and a bar joist is shown in FIGS. **20**A, **22**, and **23**. The C-channel joist **170** shown in FIGS. **20** and **21** includes a C-channel **172** fastened to an L-bracket **174** by bolts **176**. Brackets **174** are bolted or welded to two I-beams **178** (only one of which is shown) that run the length of the foundation **76** and are fastened to anchors **78** secured thereon as previously described. Threaded ends **81** of bolts project up from the anchor and are received through holes in the lower inner flange of the I-beams **178**, and receive nuts **83** to hold the I-beam in place. Inwardly opening channel (not shown) with upright 2"×2" steel tubing inserted in the channel at spaced positions therealong could be substituted for the I-beam **178**.

The C-Channels **172** are spaced at suitable intervals along the I-beam **178**, for example, every 18", and over the end walls of the foundation. Sub-flooring **179** is laid over and supported by the joists **170**. Brackets for attaching the wall modules are connected to floor by bolts **180** that are inserted through holes in the I-beam upper inner flange and through the sub-flooring. The wall modules **36** are attached to the brackets in the manner described above.

The bar joist **180** shown in FIGS. **20**A, **22** and **23** is a construction of two angle bars **182** welded to angled steel bars **184**, inturn welded to a lower angle bar **186** as shown in FIG. **20**A. The ends of the bar joist have another pair of angle bars **188** welded to them to serve as a base on which the bar joist **180** can sit on the top of foundation wall **76**. The ends of the bar joist **180** lie over the anchor, of which two types are shown in FIGS. **20**A and **22**, and are fastened thereto by bolts protruding from the anchor above the upper surface of the foundation. The wall modules **36** are fastened to brackets attached by bolts through the sub-floor **179** and the angle bars **182**.

A second story can be supported atop the peripheral wall **20** by using a C-track **190** running the length of the two opposite side walls of the peripheral wall frame, and receiving ends of space C-channels **192** therein. Vertically disposed short lengths **194** of 2"×2" steel tubing are fitted into the C-track and attached to the C-track **190** and to the C-channel **192** to secure the C-channel **192** in the C-track **190**. The short lengths **194** of 2"×2" steel tubing are also spaced at short intervals along the C-track to support the weight of the second story frame wall thereon. The entire structure is attached together with long bolts **196** which can be positioned to run through the middle of the short lengths **194** of 2"×2" steel tubing. The second story peripheral wall is assembled directly atop the top surfaces of the C-track as shown in FIGS. **24** and **25**, or the second story sub-floor **198** can be laid atop the joist and the C-track and the second floor peripheral wall can be assembled on the second story sub-floor **198**.

The invention thus enables the low cost construction of a house with design capabilities of meeting the design needs of multiple requirements without major redesign. For example, in areas that have a need for high wind resistance, the diagonal bracing in the horizontal plane of the truss lower chords **96**, and in the vertical plane through the truss upper chord apexes can be added to give very strong resistance to the racking forces exerted by wind loads on the peripheral wall **20** and on the trusses **30**. In areas where heavy snow loads can be expected, the pitch angle of the trusses can be increased to any desired angle to increase the load bearing strength and the snow shedding capability of the roof. In earthquake prone areas, the diagonal shear panels may be used extensively to give redundant load sharing capability and the horizontal and vertical diagonal truss bracing may be used to prevent the lateral forces of an earthquake from racking the roof trusses in the direction normal to their plane. The roofing material may be selected for minimum weight to minimize the inertial forces so the house moves more like a rigid unit rather than a flexible vertical cantilever. This will minimize the damage to the building caused by differential movement of the foundation and the roof so that the building will remain serviceable after the earthquake. The metal frame building is inherently immune to attacks by termites and carpenter ants as well as mold and mildew, and is inherently resistant to fire damage.

Obviously, numerous modifications and variations of the preferred embodiment disclosed herein are possible and will occur to those skilled in the art in view of this description. For example, many functions and advantages are described for the preferred embodiments, but in some uses of the invention, not all of these functions and advantages would be needed. Therefore, I contemplate the use of the invention using fewer than the complete set of noted functions and advantages. Moreover, several species and embodiments of the invention are disclosed herein, but not all are specifically claimed, although all are covered by generic claims. Nevertheless, it is my intention that each and every one of these species and embodiments, and the equivalents thereof, be encompassed and protected within the scope of the following claims, and no dedication to the public is intended by virtue of the lack of claims specific to any individual species. Accordingly, it is expressly to be understood that these modifications and variations, and the equivalents thereof, are to be considered within the spirit and scope of the invention as defined by the following claims, wherein

I claim:

1. An earthquake and wind-resistant building, comprising:

side walls made of side wall frame modules bolted together along adjacent edges, said side wall frame modules constructed of rectangular steel tubing welded together, at least some of said side wall frame modules having diagonal bracing;

end walls made of end wall frame modules bolted together along adjacent edges, said end wall frame modules constructed of rectangular steel tubing welded together, at least some of said end wall frame modules having diagonal bracing;

said end walls each having two ends, each bolted to corresponding ends of said side walls to form a peripheral wall of said building;

pockets in said side walls each defined by a floor and opposed side surfaces extending completely through said side wall from said inside face to said outside face, said floor lying below the top-most surface of said side wall;

trusses for supporting a roof on said peripheral wall, said trusses fixed in said pockets on top of said side walls and extending from said inside face through and beyond said outside face of said side walls, said pockets defined between structural members at the top of said wall, said trusses being bolted between said structural members to secure said roof of said building on said peripheral wall;

anchors set in a concrete foundation and having brackets at the top surface of the foundation positioned thereon adjacent to where bottom longitudinal members of the frame modules lie, and are fastened thereto;

vertically extending studs fastened to inside surfaces of said wall frame modules for attachment of interior wall board;

vertically extending stringers attached to outside surfaces of said wall frame modules for attachment of external siding; and

longitudinally extending perlins attached to brackets fixed to said trusses, said perlins extending over said trusses for attachment of roof sheathing.

2. A method of building a frame for a house, comprising:

constructing a plurality of rectangular end wall frame modules and a plurality of rectangular front and back side wall frame modules from rectangular steel tubing welded together using jigs to ensure accurate right angle orientation at all four outside corners of said frame modules;

each of said front and back frame modules having two upright end members, each having upper and lower ends connected at ends of upper and lower longitudinal tube members extending between and connecting said two upright end members, and having a tubular eve strut supported at opposite ends thereof on upright stub supports welded to said upper longitudinal tube member at positions offset inwardly from said upright end members, said stub supports supporting said tubular eve strut at a position spaced above said upper longitudinal tube member;

bolting a rectangular end wall frame module to a rectangular side wall frame module on each corner of said building to make a corner structure;

bolting front and back side wall frame modules between said corner structures at front and back sides of said house, respectively, and bolting end side wall frame modules between said corner structures at ends of said house, respectively, to create a continuous peripheral wall;

constructing a plurality of roof trusses from a plurality of lengths of rectangular steel tubing cut to size and welded together and to overlapping steel plates for strength at two ends and an apex;

constructing a foundation around a perimeter of said house and embedding anchors in said foundation, said anchors including a bracket positioned at the top surface of said foundation inboard from the peripheral edge of said foundation a distance equal to the thickness of said longitudinal tube members said anchor brackets being positioned along said continuous peripheral wall at locations corresponding to junctions of said side wall frame modules and junctions of said front and back side wall frame modules to hold adjacent modules together at lower corners thereof and also secure said lower corners securely to said foundation;

attaching said lower longitudinal tube members of said wall frame modules to said anchor brackets at a position adjacent to said outside peripheral edge of said foundation to secure said building to said foundation;

bolting one each of said trusses between each of said stub supports spanning said front and back side walls, and attaching purlins to an upper chord of said trusses extending thereacross for the full length of said house for attachment of a roof;

attaching stringers to outside surfaces of said peripheral wall and attaching exterior siding to said stringers;

applying vapor barrier material and inserting thermal insulation into said peripheral wall;

attaching vertically extending studs to inside surfaces of said peripheral wall for attaching wall board to said studs;

attaching longitudinally extending channels to a lower chord of said trusses for attaching ceiling wallboard to said channels.

3. A steel building frame, highly resistant to wind loads, comprising:

a peripheral wall frame of said building frame, including a plurality of frame modules, prefabricated from rectangular steel tubing, connected end-to-end at junction lines;

said frame modules having two upright end members and an upper horizontal member supported at the upper ends of said upright end members, and a lower member connected between bottom ends of said upright end members;

a plurality of steel anchors having structure for embedding in a peripheral foundation underlying said peripheral wall frame;

bracket structure connecting bottom ends of said upright end members of adjacent frame modules to each other and to said anchors to hold said frame members together and down against vertical translation away from said foundation, and against lateral translation off of said foundation;

roof trusses supported on said peripheral wall frame at frame module junction lines and bolted to said frame modules;

pockets between upper portions of said peripheral wall frame modules into which said trusses fit and to which said trusses are bolted;

said pockets having an upwardly facing floor for vertically engaging and supporting said roof trusses; said pocket floors lying at a level flush with said upper horizontal members of adjacent frame members and vertically aligned therewith;

whereby a high strength continuous tensile load path exists through steel structure from said foundation to said roof through said anchors and said peripheral wall frame to said trusses.

4. A steel building frame as defined in claim **3**, wherein:

said frame modules have two longitudinal ends defined by said upright end members; and

said pockets are located directly over two abutting upright end members of adjoining frame modules;

whereby said trusses are vertically supported directly by said upright end members.

5. A steel building frame as defined in claim **3**, wherein:

said frame modules are rectangular structures with four outer corners disposed at angles of about 90°±2°;

said frame modules being fabricated from lengths of said steel tubing welded together.

6. A steel building frame, resistant to wind loads, comprising:

a peripheral wall frame of said building frame, including a plurality of frame modules, prefabricated from rectangular steel tubing, connected end-to-end at junction lines;

a plurality of steel anchors having structure for embedding in a peripheral foundation underlying said peripheral wall frame;

said frame modules having lower members connected to said anchors to hold said frame members down against vertical translation away from said foundation, and against lateral translation off of said foundation, said frame modules have two longitudinal ends defined by upright end members;

roof trusses supported on said peripheral wall frame at frame module junction lines and bolted to said frame modules;

pockets between upper portions of said peripheral wall frame modules into which said trusses fit and to which said trusses are bolted;

said pockets are located directly over two abutting upright end members of adjoining frame modules;

said pockets have side edges that are defined by upright stub members welded atop said frame modules adjacent to and spaced from said upright end members by about one half the thickness of said truss, and said stub members on adjoining frame modules are spaced apart a distance about equal to said truss thickness;

whereby said trusses stand upright without bracing when fitted into said pockets during assembly, and said trusses are bolted to both of two adjacent frame modules with a bolt.

7. A steel building frame as defined in claim **6**, further comprising:

an eve strut welded between said stub members on at least one of said frame modules and extending longitudinally of said frame module between said stub members.

8. A steel building frame as defined in claim **7**, wherein:

said stub members are welded to upper longitudinal frame members of said modules; and

said eve strut is spaced above said upper longitudinal frame member, leaving a gap between said eve strut and said upper longitudinal frame member for access to insert and tighten a bolt through said adjacent stub members of adjoining frame modules and through a truss in said pocket between said adjacent stub members.

9. A steel building frame, highly resistant to wind loads, comprising:

a peripheral wall frame of said building frame, including a plurality of frame modules, prefabricated from rectangular steel tubing, connected end-to-end at junction lines;

a plurality of steel anchors having structure for embedding in a peripheral foundation underlying said peripheral wall frame;

said frame modules having lower members connected to said anchors to hold said frame members down against vertical translation away from said foundation, and against lateral translation off of said foundation;

roof trusses supported on said peripheral wall frame at frame module junction lines and bolted to said frame modules;

said anchors each include a bracket having a base and an upstanding flange;

said embedding structure includes a rod projecting downwardly from said base for embedding in said foundation;

said anchors are spaced along said peripheral foundation to coincide with positions of said junction lines of adjacent frame modules for attachment of said modules to said foundation at longitudinal ends of said modules;

whereby a high strength continuous tensile load path exists through steel structure from said foundation to said roof through said anchors and said peripheral wall frame to said trusses.

10. A steel building frame as defined in claim **9**, wherein:

each of said anchors includes a single bracket sized to span at least the width of two adjoining upright end members of said wall modules;

whereby said bracket is fastened to both of said adjoining modules to secure them to said foundation and to each other.

11. A steel building frame as defined in claim **10**, wherein:

said brackets are fastened to said frame modules by fasteners which extend through aligned holes in said bracket and said upright end frame members.

12. A steel building frame, highly resistant to wind loads, comprising:

a peripheral wall frame of said building frame, including a plurality of frame modules, prefabricated from rectangular steel tubing, connected end-to-end at junction lines;

a plurality of steel anchors having structure for embedding in a peripheral foundation underlying said peripheral wall frame;

said frame modules having lower members connected to said anchors to hold said frame members down against vertical translation away from said foundation, and against lateral translation off of said foundation;

roof trusses supported on said peripheral wall frame at frame module junction lines and bolted to said frame modules;

said anchors include a plate disposed flush with a top surface of said foundation;

said embedding structure includes a rod embedded in said foundation and fastened to said plate;

said anchors are spaced along said peripheral foundation to coincide with positions of said junction lines of adjacent frame modules for attachment of said modules to said foundation at longitudinal ends of said modules; whereby a high strength continuous tensile load path exists through steel structure from said foundation to said roof through said anchors and said peripheral wall frame to said trusses.

13. A steel building frame as defined in claim **12**, further comprising:

a plurality of floor joists supported on and spanning open spaces within said foundation, said floor joists secured to said foundation by bolts projecting from said plates into said joists.

14. A steel building frame as defined in claim **13**, wherein:

said frame modules are supported atop sand floor joists and bolted thereto, providing a portion of said tensile load path between said foundation and said frame modules.

15. A steel building frame, comprising:

a peripheral wall frame, including a plurality of first floor frame modules, prefabricated from rectangular steel tubing, connected end-to-end at junction lines;

a plurality of steel anchors having structure for embedding in a peripheral foundation underlying said peripheral wall frame, said anchors each include a bracket having a base and an upstanding flange;

said anchors are spaced along said peripheral foundation to coincide with positions of said junction lines of adjacent frame modules for attachment of adjacent ends of two modules to said brackets for anchoring said frames to said foundation at longitudinal ends of said modules;

said first floor frame modules having lower members connected to said anchors to hold said first floor frame members down against vertical translation away from said foundation, and against lateral translation relative to said foundation;

second floor joists supported atop and bolted to said first floor frame modules and spanning spaces within said peripheral wall frame;

said peripheral wall frame including a plurality of second floor frame modules, prefabricated from rectangular steel tubing, and connected end-to-end at junction lines, said second floor frame modules supported atop said second floor joists and bolted thereto;

roof trusses supported on said second floor frame modules over module junction lines and bolted to said frame modules;

whereby a high strength continuous tensile load path exists through steel structure from said foundation to said roof through said anchors and said peripheral wall frame and joists to said trusses.

16. A steel building frame as defined in claim **15**, wherein:

said rectangular steel tubing is about 2"×2" in cross section.

17. A steel building frame as defined in claim **15**, further comprising:

a plurality of purlins lying atop said trusses at right angles thereto, and attached to brackets prewelded to said trusses, said purlins spaced apart on said trusses sufficiently close together for supporting roof sheathing within commercially acceptable sagging deflections of said sheathing.

18. A steel building frame comprising:

a first floor frame including a plurality of first floor frame modules of a peripheral wall frame, prefabricated from rectangular steel tubing, connected end-to-end at junction lines;

a plurality of steel anchors having structure for embedding in a peripheral foundation underlying said peripheral wall frame;

said first floor frame modules having lower members connected to said anchors to hold said first floor frame members down against vertical translation away from said foundation, and against lateral translation relative to said foundation;

said first floor frame including second floor joists supported by and bolted to said first floor frame modules and spanning spaces within said peripheral wall frame;

said peripheral wall frame including a plurality of second floor frame modules, prefabricated from rectangular steel tubing, and connected end-to-end at junction lines, said second floor frame modules supported atop said first floor frame and bolted thereto;

roof trusses supported on said second floor frame modules over module junction lines and bolted to said frame modules;

pockets between upper portions of said peripheral wall second floor frame modules, said trusses received in said pockets with a snug fit and are bolted therein, said pockets being located directly over and vertically aligned with two abutting upright end members of adjoining frame modules for directly supporting said trusses on said two abutting upright end members;

whereby a high strength continuous tensile load path exists through steel structure from said foundation to said roof through said anchors and said peripheral wall frame to said trusses.

19. A modular building frame, comprising:

side walls made of side wall frame modules made of two horizontally spaced upright end members welded between ends of vertically spaced upper and lower horizontal members, said modules being bolted together along adjacent edges, said side wall frame modules constructed of rectangular steel tubing welded together, at least some of said side wall frame modules having diagonal bracing;

end walls made of end wall frame modules bolted together along adjacent edges, said end wall frame modules constructed of rectangular steel tubing welded together, at least some of said end wall frame modules having diagonal bracing;

said end walls each having two ends, each bolted to corresponding ends of said side walls to form a peripheral wall of said building;

trusses for supporting a roof on said peripheral wall;

pockets between upper portions of said peripheral wall frame modules into which said trusses fit and in which said trusses are fixed;

said pockets having an upwardly facing floor for vertically engaging and supporting said roof trusses; said pocket floors lying at a level flush with said upper horizontal members of adjacent frame members and vertically aligned directly over two abutting upright end members of adjoining frame modules, whereby said trusses are vertically supported directly by said upright end members;

said pockets defined between structural members at the top of said wall, said trusses being bolted between said structural members to secure said roof of said building on said peripheral wall;

vertically extending studs fastened to inside surfaces of said wall frame modules for attachment of interior wall board;

vertically extending stringers attached to outside surfaces of said wall frame modules for attachment of external siding; and

longitudinally extending perlins attached to brackets fixed to said trusses, said perlins extending over said trusses for attachment of roof sheathing.

20. A rectangular frame module for a modular building frame side wall having pockets atop said side wall for receiving and securely holding roof trusses upright in said pockets atop said side wall, comprising:

two upright end members, each having upper and lower ends

upper and lower longitudinal tube members each having ends welded to said two upright end members and extending between and connecting said upright end members forming a planar rectangle;

a tubular eve strut welded at opposite ends thereof to upright stub supports, which are welded to said upper longitudinal tube member at positions offset inwardly from said upright end members, said stub supports supporting said tubular eve strut at a position spaced above said upper longitudinal tube member;

vertically extending studs fastened to inside surfaces of said wall frame modules for attachment of interior wall board; and

vertically extending stringers attached to outside surfaces of said module for attachment of external siding;

whereby a plurality of said rectangular frame modules may be bolted together edge-to-edge to form said side walls, with said pockets defined between adjacent upright stub supports of adjacent frames to receive and support said trusses.

21. A rectangular frame module as defined in claim **20**, wherein:

said upright end members have holes predrilled therein on axes lying the plane of said planar rectangle, said predrilled holes being positioned vertically in said upright end members to correspond to holes predrilled in other frame modules to allow insertion of bolts through said holes whereby said modules may be fastened together edge-to-edge to form said side wall; and

said upright stub supports have holes predrilled therein on axes lying in the plane of said planar rectangle, said predrilled holes being positioned vertically in said upright stub supports to align with holes predrilled in upright stub supports of adjacent frame modules to allow insertion of bolts through said holes whereby said trusses may be fastened in said pockets.

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